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University of Mysore

(Estd.1916)

M.Sc. MICROBIOLOGY

Credit Based Choice Based Continuous Evaluation Pattern System

UNIVERSITY OF MYSORE

Department of Studies in Microbiology

Manasagangotri, Mysuru-570006

Regulations and Syllabus

Master of Science in Microbiology (M.Sc.)

(Two-year semester scheme)

Under

Credit Based Choice Based Continuous Evaluation Pattern System

CHAIRMAN
BOARD OF STUDIES
/ MICROBIOLOGY (PG)
UNIVERSITY OF MYSORE

UNIVERSITY OF MYSORE
GUIDELINES AND REGULATIONS LEADING TO
MASTER OF SCIENCE IN MICROBIOLOGY
(TWO-YEAR SEMESTER SCHEME) UNDER
CREDIT BASED CHOICE BASED CONTINUOUS EVALUATION PATTERN SYSTEM

Programme Details

Name of the Department	: Department of Studies in Microbiology
Subject	: Microbiology
Faculty	: Science and Technology
Name of the Programme	: Master of Science in Microbiology (M.Sc.)
Duration of the Programme	: 2 years divided into 4 semesters

Programme Outcomes

On completion of M.Sc. (Microbiology), students are able to:

1. Instill the intellectual skills to analyze the molecules using advance biophysical techniques such as HPLC, GC, AAS, PCR etc.
2. Perform the quantitative/ qualitative analysis of biomolecules and understand various biochemical pathways
3. Acquire knowledge and understanding the concepts of microbial genetics, molecular biology, Immunology, Enzymology.
4. Explore the scientific literature effectively and use computational tools such as bio-statistics and bioinformatics
5. Implement the knowledge in industry with regard to scale up, production, down stream processing and quality control of the various microbial products
6. Conduct the basic research related to industry-environmental issues and use of agricultural for sustainable products

Programme Specific Outcomes

1. Understand and be able to explain different branches of microbiology such as bacteriology and virology.

2. To develop laboratory skills applicable to Microbiological research in the field of environmental microbiology, industrial microbiology, food microbiology and microbial pathogenesis.

3. Design and execute experiments related to basic microbiology, immunology, molecular biology, recombinant DNA technology and microbial genetics, which will enable to execute a short research project under the supervision of teachers.

4. Equip to take up a suitable position in academia or industry, and to pursue a career in research if so desired.

University of Mysore

Department of Studies in Microbiology

Credit Based Choice Based Continuous Evaluation Pattern System

SCHEME OF THE STUDY

For B.Sc. (Honors) in Microbiology

Credits to be earned	: 40 credits
Hard core papers	: 16 credits
Soft core paper	: 16 credits
Open elective paper	: 04 credits
Project work / term work	: 04 credits

For M. Sc. in Microbiology

Credits to be earned	: 76 credits
Cumulative total of credits to be completed	: 40 credits (Honors) + 36 credits
Hard core papers	: 36 credits
Soft core papers	:32 credits
Project work / term work	:08 credits

M.Sc. in Microbiology (76 credits)

Credit Based Choice Based Continuous Evaluation Pattern System

Proposed Semester-wise distribution of the course structure for the year 2018-2019

First Semester: 20 Credits

No	Paper Code	Title Of The Course Paper	HC/SC/ OE	L:T:P	Credits
1	18251	Virology	HC	3:1:0	4
2	18252	Bacteriology	HC	3:1:0	4
Select 4 out of 5 papers					
3	18253	Mycology	SC	3:1:0	4
4	18254	Microbial Genetics	SC	3:1:0	4
5	18255	Microbial Ecology & Diversity	SC	3:1:0	4
6		Practical I (Virology &Bacteriology)	SC	0:0:2	2
7		Practical II (Mycology & Microbial Genetics)	SC	0:0:2	2

HC=02; SC=04; OE=0

Second Semester: 20 Credit

No	Paper Code	Title Of The Course Paper	HC/SC /OE	L:T:P	Credits
1	18261	Microbial Physiology	HC	3:1:0	4
2	18262	Immunology	HC	3:1:0	4
Select 3 out of 4 papers					
3	18263	Food Microbiology	SC	3:1:0	
4	18264	Soil Microbiology	SC	3:1:0	4
5		Practical III (Microbial Physiology & Immunology)	SC	0:0:2	2

6		Practical IV (Food Microbiology)	SC	0:0:2	2
7	18265	Microbial Diversity	OE	2:2:0	4

HC=02; SC=03; OE=1

Third semester: 20 credi

NO	Paper Code	Title Of The Course Paper	HC/SC /OE	L:T:P	Credits
1	18271	Molecular Biology	HC	3:1:0	4
2	18272	Genetic Engineering	HC	3:1:0	4
3	18273	Industrial Microbiology	HC	3:1:0	4
Select 3 out of 4 papers					
4	18274	Medical Microbiology	SC	3:1:0	4
5	18275	Clinical & Diagnostic	SC	3:1:0	4
6		Practical V (Molecular Biology & Genetic Engineering)	SC	0:0:2	2
7		Practical VI (Industrial Microbiology & Medical Microbiology)	SC	0:0:2	2
8	18276	Techniques in Microbiology	OE	1:1:0	2

HC=02; SC=03; OE=01

Fourth Semester: 18 credit

NO	Paper Code	Title Of The Course Paper	HC/SC /OE	L:T:P	Credits
1	18281	Agricultural Microbiology	HC	3:1:0	4
Select 2 out of 3 papers					
2	18282	Environmental Microbiology	SC	3:1:0	4

3	18283	Genomics & Proteomics	SC	3:1:0	4
4		Practical VII (Agricultural Microbiology & Environmental Microbiology)	SC	0:0:2	2
5		Project Work	HC	0:2:6	8

HC=01; SC=02; PW=01

Grand Total Credits: 76

FIRST SEMESTER

HARDCORE

COURSE-I: VIROLOGY **48 Hr**

Course Outcome

Upon successful completion of the course, the student would have gained knowledge regarding the following aspects;

- classification of viruses
- Tools and methods employed for studying viruses mode of transmission, patterns of infection, virus virulence, and host defense against virus infection
- Knowledge about existing viral vaccines and anti-viral drugs, emerging viruses.

Pedagogy

Virology is a sub-discipline of Microbiology which focuses on the basic knowledge of viruses, their reproduction and pathogenesis within a host cell. The contents of the course are divided into four units. This course will emphasize basic concepts of viruses, their diversity (structural, host range and genetic), various methods employed in virus studies, replication strategies, host virus interactions, emerging viral diseases, antiviral strategies in prevention and control of viral diseases and their applications, evolution and future prospective. These concepts are taught across thirty two hours, which include lectures in which students are provided information and illustrations of various virus aspects, and tutorials in which students present seminars of the topics assigned. The lecture will impart students with knowledge and make them understand how viruses are built, replicate and evolve, cause disease, prevention of infection and their applications. The knowledge gained about viruses helps the students to develop interest in this field and helps the students to work in laboratories that are interested in isolation of viruses from various ecological niche, molecular pathogenesis, vaccines, antiviral drugs, applications such as virus vectors development and in health and diagnostic laboratories.

Course Content: **48 Hr**

UNIT-I **12 Hr**

The science of virology: Concept and scope of virology. Definitive properties of viruses: Morphology, Ultra structure, Chemical composition - proteins, nucleic acids, and other contents. Classification and nomenclature of viruses. Evolutionary importance of viruses.

Working with viruses: Visualization and enumeration of virus particles, Biological activity of viruses, Physical and chemical manipulation of the structural components of viruses, Characterization of viral product expressed in the infected cells. Isolation and purification of viruses, Detection of viruses: physical, biological, immunological and molecular methods.

UNIT-II **12 Hr**

Virus replication Strategies: Principal events involved in replication: Adsorption, penetration, uncoating nucleic acid and protein synthesis, intracellular trafficking, assembly, maturation and release, viral-host interaction, Host response to viral infection.

Replication patterns of specific viruses: Identification of virus prototypes associated with different virus replication schemes; Details on important viruses namely Herpes virus, Poliovirus, Influenza virus, SV40 and Adeno Virus, Poxviruses, Hepatitis Viruses, Retroviruses.

UNIT-III **12 Hr**

Propagation, purification, characterization and identification and genomics of plant viruses: General methods of propagation of plant viruses; purification of plant viruses using centrifugation, chromatography and electrophoresis techniques, methods employed in identification of plant viruses.

Sub-viral particles: Discovery, Structure, Classification, replication and diseases caused by Satellite, Satellites virus, Virusoids, Viroids and Prions.

Anti-viral strategies-prevention and control of viral diseases: Host specific and Non specific defense mechanisms involved in resistance to and recovery from virus infections. Role of interferon in viral infections. Viral Chemotherapy: Nucleoside analogs, reverse transcriptase inhibitors, protease inhibitors, History of vaccines especially smallpox and polio. New methods: subunit vaccines, antiidiotype and DNA vaccines.

UNIT-IV **12 Hr**

Microbial viruses: Diversity, classification, characteristics and applications of bacteriophages, and general account on algal, fungal and protozoan viruses.

Viruses and the future: Promises and problems. Emerging diseases, sources and causes of emergent virus diseases.

References:

1. Marc H.V. van Regenmortel , Brian W.J. Mahy (2009) Desk Encyclopedia of General Virology , 1 edition, AcademicPress.
2. Alan J. Cann (2011) Principles of Molecular Virology, 5th edition ,Elsevier
3. Clokie, Martha R. J., Kropinski, Andrew (2009) Bacteriophages, Methods and Protocols, Volume 1: Isolation, Characterization, and Interactions, HumanaPress

4. Edward K. Wagner, Martinez J. Hewlett , David C. Bloom , David Camerini (2007), Basic Virology, 3rd Edition, John Wiley &Sons.
5. Hunter-Fujita, Frances R., Philip F. Entwistle, Hugh F. Evans, and Norman E. Crook. Insect viruses and pest management. John Wiley & Sons Ltd,1998.
6. Jane S. Flint, Lynn W Enquist, Anna Marie Shalka (2004) Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses, American Society for Microbiology
7. John Carter, Venetia A. Saunders,(2007),Virology: Principles and Applications. John Wiley & Sons, west Susscex ,England.
8. Lobocka, Malgorzata, and Waclaw T. Szybalski, eds.(2012) Bacteriophages. Part 2 , AcademicPress
9. Matthews, Richard Ellis Ford, and Roger Hull.(2002) Matthews' plant virology. 4th edition, Gulf Professional Publishing.
10. Nigel Dimmock, Andrew Easton, Keith Leppard, 2009, Introduction to Modern Virology, 6th Edition,Wiley-Blackwell.

COURSE-II: BACTERIOLOGY **48 Hr**

Course Outcome:

Upon successful completion of the course, the student:

- Are able to describe the morphological features, cell arrangement and structural components of bacterial cell in detail and differentiate between Gram-positive and Gram-negative bacteria.
- Will have gained knowledge about cell wall structure and extracellular appendages in different bacteria and will be acquainted with current methodologies available for production of protoplasts and L-forms
- Know key features of some model archaeal organisms.
- Understand Quorum sensing in bacteria and its significance in competence, sporulation and antibiotic resistance.

Pedagogy:

Bacteriology is the sub-disciplinary course of Microbiology. Bacteriology is the study of bacteria and their importance in medicinal and other areas such as agriculture, industries. Bacteria are single celled microorganisms which can live as independent organisms or dependently as parasites. Superficially bacteria appear to be relatively simple forms of life; in fact they are sophisticated and highly adaptable.

The discipline of bacteriology evolved from the need to test and apply the germ theory of disease and from economic concern relating to the spoilage of food and wine. The contents of this course are divided into various units and each unit focuses on various aspects of bacteriology such as serial dilution technique, microscopy, staining technique, classification and taxonomy and economic importance of bacteria.

The knowledge gained under this subject helps the student to work in laboratories, pharmacological industries, and in any industries where microorganisms are used as chief source.

Course Content

UNIT-I **12 Hr**

Introduction: Important events in development of bacteriology, Scope and relevance of bacteriology. Economic importance of bacteria.

Cell Structure: An overview of bacterial size, shape and arrangement, structure, chemical composition of cell wall of Archaebacteria, gram-negative bacteria, gram-positive bacteria and acid fast bacteria, cell wall deficient organisms including L-form structure, composition and function of cell membrane, capsule, flagella, pili, Inclusion bodies, ribosomes, mesosomes, reserve food materials , magnetosomes and phycobilisomes, endospores, bacterial nucleic acids – chromosome, plasmid, transposons, integrons and antibiotic resistance cassettes.

Microscopy: Working Principles of bright field microscope, fluorescent microscope, dark field microscope, phase contrast microscope, stereo microscope, confocal microscopy and electron microscope. Preparation of sample for electron microscopic studies. Application and importance of above microscopes. Measurement of microscopicobjects.

UNIT-II **12 Hr**

Bacterial classification and taxonomy: Criteria for the classification of bacteria. Phenetic, Phylogenetic, Genotypic, Numerical taxonomy. Techniques for determining microbial taxonomy and Phylogeny. ICNB rules. Classification systems of major categories and groups of bacteria according to Bergey are manual of Systematic Bacteriology and Determinative Bacteriology. Non-culturable methods for the identification of pathogenic microorganisms.

UNIT-III **12 Hr**

Growth, Cultivation and control of Bacteria: Nutrient requirements, nutritional types of bacteria, culture media, classification of media. Growth: Nutritional uptake, Growth kinetics, generation time, growth curve, factors affecting growth. Methods for measurement of microbial growth – direct microscopy, viable count estimates, turbidometry, and biomass. Aerobic, anaerobic, batch, continuous and synchronous cultures. Methods of pure culture isolation, Enrichment culturing techniques, single cell isolation, and pure culture development. Preservation and Maintenance of Microbial cultures: Repeated sub culturing, preservation at low temperature, sterile soil preservation, mineral oil preservation, deep freezing and liquid nitrogen preservation, lyophilization. Advantages and disadvantages of each method. Control of

microorganisms: Antimicrobial agents, physical and chemical methods. Principles, functioning and types of Biosafety cabinets.

UNIT-IV **12 Hr**

Characteristics and Salient features of major groups of Bacteria: Archaebacteria: general characteristics and classification; extremophiles, halophiles, thermophiles and barophiles; General characteristics, classification, diversity and distribution, economic importance of **Actinomycetes, Cyanobacteria**. **Bioluminescent bacteria;** characteristics and examples, mechanism of bioluminescence. General characteristics, life cycle, growth, multiplication and significance of **Mycoplasma, Rickettsiae and Chlamydia**

References:

1. Sherwood, and Woolverton Willey (2007), Prescott, Harley, and Klein's Microbiology (7th International Edition),McGraw-Hill
2. Mara, Duncan, and Nigel J. Horan, (2003) . Handbook of water and wastewater Microbiology, Academic Press.
3. Michael T. Madigan, David P. Clark, David Stahl, John M. Martinko, 2012, Brock Biology of Microorganisms 13th Edition, BenjaminCummings
4. Jacquelyn G. Black (2012) Microbiology: Principles and Explorations ,8th edition,Wiley
5. Michael J. Leboffe, Burton E. Pierce , David Ferguson (2012) Microbiology Laboratory Theory & Application, Brief, 2nd Edition, Morton PublishingCompany
6. Jeffrey C. Pommerville (2010) Alcamo's Fundamentals of Microbiology, 9th Revised edition, Jones and Bartlett Publishers,Inc
7. Jeffrey C. Pommerville (2010) Alcamo's Laboratory Fundamentals of Microbiology, Jones and Bartlett Publishers,Inc
8. Alfred Brown (2011) Benson's Microbiological Applications Short Version (Brown, MicrobioligicalApplications), 12th edition, McGraw-HillScience/Engineering/Math.
9. Jerome J. Perry , James Staley , Stephen Lory (2002), Microbial Life, SinauerAssociates.
10. Stuart Hogg (2013) Essential Microbiology, 2nd Edition,Wiley-Blackwell

COURSE- III: MYCOLOGY **48 Hr**

Course outcome:

- To understand the world of fungi and lichens,
- Appreciate the adaptive strategies of the fungi and lichens,
- understand the economic and pathological importance of fungi, and identify common plant diseases and device control measures
- In tutorial classes they do group discussions on use full and pathogenesis of different fungi involved in daily life.

- In practical classes they mount the fungi, learn microscopic views and the key characteristics to identify different species of fungi.

Pedagogy:

Mycology is the sub-branch of Microbiology, which is concerned with the study of fungi. It includes the study of taxonomic classification, fungal genetics, and biochemical properties. Fungi are fundamental for life as symbionts, also takes part in biodegradation process. They are socially and economically important as they are capable of causing diseases in plants, animals and human beings.

Study of fungi is highly important as it plays major role in production of food supplements like SCP, fermentation industries, vitamins, enzymes, organic acids. Another notable element is production of secondary metabolites like antibiotics which acts against other microbes. In agriculture, knowledge pertaining to fungi should be maximum as it causes plant diseases leading to economic loss. Fungal infections have more devastating effects on human health and hence clinical significance of fungi has gained more attention, due to its wide applications and effects, the study of fungi is highly recommended.

Course Content

UNIT-I **12 Hr**

Introduction: History and Development of Mycology, scope of mycology. Recent developments in Mycology.

Fungal taxonomy: Taxonomic problems associated with variation in fungi, Classification of fungi (Alexopoulos and Mims).

UNIT-II **12 Hr**

General characteristics of fungi and reproduction: Morphology and somatic structures: The thallus, organization, fungal cell, nuclear components, specialized somatic structures; Aggregation of hyphae, tissues, mycangia, General aspects of fungal nutrition and reproduction (Asexual, Sexual reproduction, Heterothalism and Parasexuality)

UNIT-III **12 Hr**

Salient features of fungal major groups: Chytridiomycota, Zygomycota, Basidiomycota, Ascomycota, Deuteromycota, Oomycota, Hypochytrio mycota, Labyrinthulomycota, Plasmodiophoromycota and Myxomycota. Symbiotic fungi-Lichens.

UNIT-IV **12 Hr**

Economic importance of fungi: Fungi as biocontrol agent, Economic importance of Fungi in Agriculture, Industry and medicine. Fungi as SCP, Fungi as parasites of human and plants.Role of fungi in bio deterioration of wood and paper.Mycorrhiza – ectomycorrhiza, endomycorrhiza, vesicular arbuscularmycorrhiza. Fungi as insect symbiont.

Reference:

1. Alexopoulas C J and Mims C W, 1979 Introductory Mycology 3rd edn, Wiley Eastern.,NewDelhi.
2. Deacon, J W, 1997- Modern Mycology 3rd Edition, Blackwell Science publishers,London.
3. Mehrotra, RS &Aneja, K R, 1998. An Introduction to Mycology. New Age International Pvt. Ltd. NewDelhi.
4. Odum, E.P. 1971. Fundamentals of Ecology; Third Edition. Toppan Co. Ltd. Tokyo, Japan.
5. Mercedes S. Foster& Gerald F. Bills (2011) Biodiversity of Fungi: Inventory and Monitoring Methods. AcademicPress
6. Michael John Carlile, Sarah C. Watkinson, G. W. Gooday (2007) The fungi. Academic Press. London, U. K
7. Kevin Kavanagh (2011) Fungi: Biology and Applications. John Wiley & Sons, Sussex,U.K.
8. David Moore, Geoffrey D. Robson, Anthony P. J. Trinci (2011) 21st Century Guidebook to Fungi. Cambridge UniversityPress.

COURSE-IV: MICROBIAL GENETICS **48 Hr**

Course outcome:

- Can discuss the importance of mutation analysis, can analyze mutations by complementation and recombination tests, and can design a strategy to create gene replacement in bacteria
- Is able to explain how plasmid copy number is regulated, can differentiate between Hfr strains and strains carrying F plasmid, and can construct a genetic map of bacterial genome using conjugation-based method
- Is able to compare and contrast generalized versus specialized transduction, knows how to construct genetic linkage maps using two-factor and three factor cross, is able to discuss the basis of natural competence in bacteria.
- Is able to list the events in the lytic and lysogenic phases of lambda phage life cycle and the regulatory factors and events involved.
- Can list the outcomes of transposition events, can design strategies to mutagenize bacteria using transposons, can explain the construction of conditional knockouts
- Can differentiate between positive and negative regulation of gene expression, inducible and repressible systems. Can describe the regulation of the lac, trp, gal,ara and tol operons.
- Will have learnt about the model organisms used in biological studies.

Pedagogy:

Microbial genetics deals with the transmission of hereditary characters in microorganisms like bacteria, viruses and algae which play a unique role in developing field of molecular and cell biology and plays wide role in applications in the field of medicine, agriculture, food and pharmaceutical industry. The benefits of microbial

genetics in the field of agriculture are increased in crop yields which reduce the cost for food or drug production, reduce need for pesticide and medical benefits to the worlds growing population by recombinant DNA technology and as vectors.

The importance of genetics study involves; to understand the gene function of microorganisms. Microbes provide relatively simple system for studying genetic phenomenon and thus useful to other higher organisms.
Microbes provide many value added products like antibiotics, growth hormones etc. Microbial genetics will be helpful to increase these products productivity by microbial technology. Understanding the genetics of disease-causing microorganisms especially virus, bacteria will help to develop strategies to control disease. Microbial genetics will be useful to study the gene transfer from one organism to another and its contribution for genetic variations such as virulence, antibiotic resistance etc.

Course Content

UNIT-I **12 Hr**

Concepts in Microbial Genetics: History and developments of Microbial genetics. Essentials of microbial genetics: Microbes as Genetic Tools for Basic and Applied Genetic studies. Advantages and disadvantages of Microbes, Generalized reproductive cycles of microbes- *Neurospora*, *Saccharomyces, Chlamydomonas* and *Acetabularia.*

UNIT-II **12 Hr**

Viral Genetics: Lytic and Lysogenic cycles, Phage Phenotypes, Phenotypic Mixing, Recombination in viruses: Mutations, Recombination and Mapping.
Bacterial Genetics: Bacterial Transformation: Types of transformation mechanisms found in prokaryotes, Bacterial Conjugation: properties of the F plasmid, F+ x F - mating, F' x F- conjugation, Hfr conjugation. Transduction: Generalized and specialized transduction, Transposable elements.

UNIT-III **12 Hr**

Fungal Genetics: *Neurospora*- Tetrad analysis and linkage detection - 2 point and 3 point crosses, chromatid and chiasma interference, Mitotic recombination in *Neurospora*and*Aspergillus*.
Algal Genetics: *Chlamydomonas*- unordered tetrad analysis - Recombination and Mapping, Nucleocytoplasmic interactions and gene expression in *Acetabularia*. Extra nuclear (Cytoplasmic) inheritance.

UNIT-IV **12 Hr**

Mutation and mutagenesis: Nature, type and effects of mutations. Mutagenesis – physical and chemical mutagens, base and nucleoside analog, alkylating agents, interrelating agents, ionizing radiation. Induction and detection of mutation in microorganisms. Site directed mutagenesis and its applications.

References:

1. Larry Snyder, Joseph E. Peters, Tina M. Henkin, Wendy Champness (2013) Molecular Genetics of Bacteria, 4th Edition; ASMPress
2. D. Peter Snustad, Michael J. Simmons (2011) Principles of Genetics, 6th Edition;Wiley
3. Stanley R.Maloy, Jhon E. Cronan, Jr. David Freifelder (1994) Microbial Genetics (Jones and Bartlett Series in Biology),2nd edition; Jones and BartlettPublishers
4. Uldis N. Streips, Ronald E. Yasbin (2002) Modern Microbial Genetics, 2nd edition;Wiley-Liss
5. Nancy Jo Trun, J. E. Trempy (2003) Fundamental Bacterial Genetics;Wiley-Blackwell
6. John R. S. Fincham (1996) Microbial and Molecular Genetics; HodderArnold
7. Venetia A. Saunders (1987) Microbial genetics applied to biotechnology :principles and techniques of gene transfer and manipulation;Springer
8. Sriram Sridhar (2005) Genetics and Microbial Biotechnology; Dominant Publishers & Distributors
9. Dr. Evelyn J. Biluk (2012)Microbiology Study Guide: Microbial Genetics, Controlling Microbial Growth, and Antimicrobial Agents; CreateSpace Independent Publishing Platform
10. Royston C. Clowes, William Hayes (1968) Experiments in Microbial Genetics; Blackwell Science Ltd
11. Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick (2012) Lewin's GENES XI, 11 edition; Jones & BartlettLearning
12. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick (2013) Molecular Biology of the Gene, 7 edition;BenjaminCummings

SOFTCORE

COURSE-V: MICROBIAL ECOLOGY AND DIVERSITY **48 Hr**

Course Outcome

- To understand the ubiquitous nature of microbes.
- To provide knowledge on characteristics of Microbes Outcome
- Students able to differentiate various groups of Microbes
- Get knowledge on adaptability of extremophiles
- Knowledge about microbial taxonomy.
- To create awareness on evolutionary relationship of ecosystem
- To learn about individual ecosystem and its interactions.
- To understand the concepts of community ecology Outcome
- Able to understand the role of microbes in ecology

Pedagogy

Microbial ecology and diversity is a sub discipline of microbiology (environmental Microbiology) which focuses on the huge diversity of microbes, its interaction among themselves and the ecosystem. Microbes in their natural environments, microbes interact with each other, with plants and animals. Such interactions are essential for ecosystem function and may relate to plant and animal health, biogeochemical cycles and numerous other processes.

Overall this course enables students to learn how the microbial world rules over the entire ecosystem focusing on their interactions which form the basis of survival. The study helps us improve our lives via the use of microbes in environmental restoration, food production, bio-engineering of useful products such as antibiotics, food supplements and chemicals. This course is for all biology, allied heath, environmentalists and microbiology students.

The knowledge gained under this subject helps the students to work in laboratories like pharmacological industries, clinical health and diagnostic laboratories, environmental research fields, microbial research and any industry where microorganisms and involved. The need of the hour is to focus on the importance of conservation of microbial diversity mainly the role of culture centers in conservation.

Course Content

UNIT-I **12 Hr**

Introduction to microbial ecology: Structure of microbial communities. Interaction among microbial populations. Interaction between microorganisms and plants. Biotransformation, biodegradation, bioremediation and phytoremediation.
Ecological and Evolutionary diversity (Genetic diversity) of microbial world
Development of Microbial communities: Dynamics of community, ecological succession, structure, dispersion, microbial communities in nature and ecosystem models

UNIT-II **12 Hr**

Physiological Ecology of microorganisms: Adaptation to environmental conditions - abiotic limitations to microbial growth.
Viral Diversity: Group I – T2 Bacteriophage, Group II – Banana bunchy top virus, Group III – Reovirus, Group IV- TMV, Group V – Rhabdovirus, Group VI – HIV, Group VII – Hepatitis virus.
Sub-viral particles: Discovery, Structure, Classification, replication and diseases caused by Satellite, Satellites virus, Virusoids, Viroids and Prions.

UNIT-III **12 Hr**

Bacterial Diversity: Archaebacteria, Photosynthetic Eubacteria, Chemoautotrophic and Methophilic Eubacteria, Gliding Eubacteria, Spirochetes, Rickettsiae and Chlamydiae, Actinomycetes, Mollicutes, Protists
Fungal Diversity: salient features of the following group: Zygomycota (*Rhizopus*), Ascomycota *Neurospora*), Basidiomycota (*Agaricus*), Deuteromycota (*Penicillium*), Chytridiomycota (*Allomyces*) Myxomycota and Yeast.

UNIT-IV **12 Hr**

Importance and Conservation of Microbial Diversity: Importance of microbial diversity in environment, pharmaceuticals & human health. Metagenomics. Importance of conservation. *In situ* conservation and *Ex situ* conservation. Role of culture collection centers in conservation.

References

1. OladeleOgunseitan (2008) Microbial Diversity: Form and Function in Prokaryotes; Wiley-Blackwell
2. Ronald M. Atlas, Richard Bartha (1997) Microbial Ecology: Fundamentals and Applications (4th Edition); BenjaminCummings
3. David L. Kirchman (2012) Processes in Microbial Ecology; Oxford UniversityPress
4. David L. Kirchman (2008) Microbial Ecology of the Oceans; Wiley-Liss
5. McArthur, J. Vaun (2006) Microbial Ecology An Evolutionary Approach; AcademicPress
6. Atlas, Ronald M., Bartha, Richard (1997) Microbial Ecology Fundamentals and Applications; Addison-Wesley
7. Nelson, Karen E. (1997) Advances in Microbial Ecology;Springer
8. Pierre Davet (2004)Microbial Ecology of the Soil and Plant Growth; Science PubInc
9. Osborn, A. M., Smith, Cindy (2005) Molecular Microbial Ecology; Taylor & FrancisGroup
10. OladeleOgunseitan (2004) Microbial Diversity: Form and Function in Prokaryotes; Wiley-Blackwell
11. Satyanarayana, T., Johri, B. N. (2005) Microbial Diversity: Current Perspectives and Potential Applications; I.K. International Publishing House Pvt.,Limited
12. James W.Brown (2014) Principles of Microbial Diversity; ASMPress
13. Colwell, R. R., Simidu, Usio, Ohwada, Kouicki (1996) Microbial Diversity in Time and Space; Springer

Practical's I (Virology and Bacteriology)

1. Laboratory safety rules
2. Microscopic measurement of microorganisms by micrometry
3. Culturing and maintenance of bacterial cultures
4. Isolation and enumeration of bacteria from soil
5. Isolation and enumeration of bacteria from water
6. Cultural characteristics of bacteria
7. Staining techniques – simple (positive and negative), differential (Grams and acid fast), structural (endospore and capsule)
8. Motility test (hanging drop method and soft agar method)
9. Biochemical tests for the identification of bacteria – catalase, oxidase, IMViC, Urease, TSIA, Nitrate reduction, gelatin, starch, casein, chitin and esculin hydrolysis.
10. Determination of growth curve in E.coli.
11. Diauxic growth curve in E.coli
12. Isolation of coliphages from sewage
13. Study of morphological changes due to viral infection in plants

Practicals II (Mycology and Microbial Genetics)

1. Isolation of slime molds.
2. Isolation of aquatic fungi.
3. Isolation of soil fungi.
4. Isolation of fungi from air.
5. Isolation of fungi from cereals and cereal based products.
6. Study of the following representative genera: *Aspergillus, Penicillium, Fusarium, Neurospora, Saccharomyces, Erysiphae, Polyporus, Agaricus, Puccinia, Ustilago, Alternaria, Drechslera, Saprolegnia, Rhizopus, Trichoderma*and symbiotic fungi-Lichens.
7. Measurement of concentration of fungal conidia by Haemocytometer.
8. Measurement of fungal cells by Micrometer.
9. Replica plating technique for transfer of bacterial colonies.
10. Ultra-violet killing curve and determination of mutant types in *Saccharomycescerevisiae.*
11. Induction of mutation
12. Isolation of streptomycin resistant strain of *E .coli* by gradient plate method.
13. Ames test
14. Isolation of genomic DNA from bacteria by heat lysis method.
15. Isolation of genomic DNA from yeast by DNA spooning method.

SECOND SEMESTER

HARDCORE

COURSE-I: MICROBIAL PHYSIOLOGY **48 Hr**

Course Outcome:

- Learn the methods of measuring microbial growth, calculating growth kinetic parameters with understanding of steady state and continuous growth.
- Knowledge of primary, secondary and group translocation transport systems existing in bacteria, simultaneously learning membrane transport proteins and kinetics of solute transport.
- Understand the central metabolic pathways for carbon metabolism in bacteria and their regulation in diverse physiological conditions. This allows students to apply the acquired knowledge in engineering metabolic pathways for developing industrially useful strains as well as lipid and nucleotide metabolism in bacteria.
- Learn and understand the basic concepts of enzyme biochemistry, kinetics and regulation.
- Knowledge about stress response in bacteria

Pedagogy:

Microbial physiology is defined as the study of microbial cell functions which includes the study of microbial growth, microbial metabolism and microbial cell structures. The contents of the course are divided into four main chapters or units those are: A) Microbial physiology, B) Carbohydrate metabolism, C) lipid metabolism, D) Microbial photosynthesis and each unit focuses on various aspects of microbial physiology.

Microbial physiology is an important research field, not only in fundamental research on microbial species but also in all applied aspects of microbiology including physiology of the aerobic microorganisms and anaerobic microbial communities that play an important role in environmental biotechnological processes, such as waste water treatment, soil remediation, production of chemicals , biofuels and recovery of metals.

Course Content

UNIT-I **12 Hr**

Microbial Physiology: Microbial Energetics, The role of ATP in metabolism. Microbial enzymes: Structure and Classification, Mechanism of Enzyme actions: Lock and Key model, induced fit Theory, Factors affecting rates of enzyme mediated reactions (pH, temperature and substrate and enzyme concentration), Enzyme Inhibition and Enzyme regulation.

UNIT-II **12 Hr**

Metabolism of Carbohydrate: Glycolysis, Citric acid Cycle and different types of Phosphorylation, Fates of pyruvate, Fermentation. Utilization of sugars other than glucose: Lactose, Galactose, Maltose, Mannitol. Degradation of cellulose, Starch and Glycogen.

UNIT-III **12 Hr**

Metabolism of other Substrates: **Lipid metabolism:** β-oxidation, Biosynthesis of fatty acids, degradation of fatty acids. **Nitrogen metabolism**: Nitrogen metabolism, Biological nitrogen fixation process, symbiotic and non-symbiotic nitrogen fixation. Urea cycle, degradation and biosynthesis of essential and non-essential amino acids. **Nucleic acid metabolism**: Biosynthesis and degradation of purines and pyrimidines.

UNIT-IV **12 Hr**

Microbial Photosynthesis: Photosynthetic Pigments and apparatus in bacteria. Oxygenic and Anoxygenic. Photosynthesis. Autotropic CO2 fixation and mechanism of Photosythesis.Utilizationof light energy by Halobacteria.

Autotrophic Mechanisms in bacteria: Hydrogen bacteria, Nitrifying bacteria, Purple sulphur bacteria, Non-sulfur bacteria, Green sulfur bacteria, Iron bacteria, Methylotrophs. **Microbial Stress Responses:** Oxidative stress, Thermal stress, Starvation stress, Aerobic to anaerobic transitions. Biofilm and quorum sensing

References:

1. Albert G. Moat,Michael P. Spector John W. Foster (2009) Microbial Physiology,;BWSTM
2. Albert G. Moat,Michael P. Spector John W. Foster (2009) Microbial Physiology;BWSTM
3. Byung Hong Kim,Geoffrey Michael Gadd (2008) Bacterial Physiology and Metabolism; Cambridge UniversityPress
4. Daniel R.Caldwell (1999) Microbial Physiology and metabolism ; Star PubCo

5. Daniel R.Caldwell (1999) Microbial Physiology and metabolism,; Star PubCo
6. David White, James Drummond , Clay Fuqua (2011)The Physiology and Biochemistry of Prokaryotes, Oxford UniversityPress
7. Frederick C. Neidhardt, John L. Ingraham ,MoselioSchaechter (1990)Physiology of the Bacterial Cell: A Molecular Approach; Sinauer AssociatesInc
8. Robert K. Poole (2014) Advances in Microbial Systems Biology, Volume 64 (Advances in Microbial Physiology); AcademicPress
9. Rose, Anthony H. ()Advances in Microbial Physiology, Vol. 9; Elsevier Science & Technology Book
10. Rose, Anthony H. (1976) Chemical Microbiology An Introduction to Microbial Physiology; Basic Books

Course-II: Immunology **48 Hr**

Course Outcome:

- Will be able to understand the fundamental bases of immune system and immune response
- Will be able to gather information about the structure and organization of various components of the immune system
- Will be able to understand the genetic organization of the genes meant for expression of immune cell receptors and the bases of the generation of their diversity
- Will be able to understand the operation and the mechanisms which underlie the immune response
- Will be able to apply the knowledge gained to understand the phenomena like host defense, hypersensitivity (allergy), organ transplantation and certain immunological diseases

Pedagogy:

Immunology is the branch of biology which deals with various aspects that forms an integrated network of cells, molecules, and organs within the immune system. This course helps students to learn and understand basic concepts as well as its application in various fields of biology.

The content of the course consist of four units where each unit focuses on basic aspects of immunology and its application. The course begins with the brief introduction regarding overview of immune system followed by the mechanism of immunological reactions, immunotechniques, immunodiagnosis and its application in the field of medicine. At the end of each unit a student is able to understand the development of immune system immune response against diseases, and autoimmunity.

Studying this subject will equip students with basic practical skills to work in vast fields like pathology, pharmacy industries, diagnostics and hospitals.

Course Content

UNIT-I **12 Hr**

Introduction to Immunology: An overview of immune system, Phagocytes, Natural killer cells, mast cells, basophils, Dendritic cells and other cells of the inmate immune system. Immunity**:** Types- Innate immunity: (nonspecific) physical, biochemical and genetic factors involved in governing innate immunity, molecules of inmate immunity – complement, acute phase proteins and interferons; Chemokines and Cytokines . Acquired immunity: (specific) natural, artificial, passive immunity, humoral or antibody mediated immunity, cell mediatedimmunity.

Antigens and Antibodies: Antigen processing and presentation, properties of antigen, Super antigen, Hapten; Haptens and the study of antigenicity Microbes as antigen Antigen recognition and MHC molecules. Antibodies (Immunooglobulins) – structure and function, clonal selection, monoclonal antibodies and its clinical applications, Antibody engineering (Construction of monoclonal antibodies Lymphoma and other diseases by genetically engineeredantibodies).

UNIT-II **12 Hr**

Hypersensititivity: Hypersensitivity reactions, Types and their roles in Immunopathologicalprocesses.

Autoimmune processes: Immunologic tolerance, genetic predisposition to the development of autoimmune processes. Autoimmune disorders- Immunopathogenesis of celiac disease, myasthenia gravis, sclerosis multiplex, psoriasis vulgaris**,** Rheumatoid arthritis) Immunodeficiency diseases, Hormones and environmental factors in induction of autoimmune processes.

UNIT-III **12 Hr**

Transplantation of tissues and organs: Nomenclature of transplantations. Recognition of self and non- self-Transplantation reactions HvG and GvH. Exception from rejections.Kidney and bone marrow transplantations.

Tumours and immune system: Etiology of malignant transformations of cells (physical, chemical and biological factors involved in). Immunological surveillance. Escape mechanisms of tumor cells from immunological surveillance. Metastatic processes. Immunodiagnosis and Immunotherapy.

UNIT-IV **12 Hr**

Vaccines and Vaccination: Vaccines – definition, types, Antigens used as Vaccines, effectiveness of vaccines, Vaccine safety, current vaccines, adjuvants, active immunization and passive immunization .**Manipulation of immune mechanisms:** Immunoprevention, Immunoprophylaxis, Immunostimulatory and Immunosuppressivedrugs.

Immunotechniques and Immunodiagnosis: Antigens and Antibody reactions *in vitro;* Agglutination, complement fixation, ELISA, Immunodiffusion,

Immunoelectrophoresis, Immunoflourescence, Immunoprecipitation, Radioimmunoassay and serotyping.

References:

1. Abul K. Abbas (2014)Cellular and Molecular Immunology, ;Saunders
2. Judy Owen , Jenni Punt, Sharon Stranford (2013) Kuby Immunology; W. H.Freeman
3. Abul K. Abbas , Andrew H. H. Lichtman , Shiv Pillai (2012)Basic Immunology: Functions and Disorders of the Immune System, ;Saunders
4. Peter Parham (2009)The Immune System, 3rd Edition; GarlandScience
5. Abul K. Abbas , Andrew H. H. Lichtman , Shiv Pillai (2011)Cellular and Molecular Immunology; Saunders
6. George Pinchuk (2001) Schaum's Outline of Immunology;McGraw-Hill
7. William E. Paul (2012) Fundamental Immunology;LWW
8. Helen Chapel , ManselHaeney, SirajMisbah, Neil Snowden (2014) Essentials of Clinical Immunology;Wiley-Blackwell
9. Louise Hawley, Benjamin Clarke, Richard J. Ziegler (2013) Microbiology and Immunology;LWW
10. Delves, Peter J., Martin, Seamus J., Burton, Dennis R.(2011)Roitt's Essential Immunology;Wiley& Sons, Incorporated,John.

SOFTCORE

COURSE –III: FOOD MICROBIOLOGY **48Hr**

Course Outcome:

- Learn about production and evaluation of the quality of starter cultures and fermented milk products and understands the use and production of probiotics, prebiotics and nutraceuticals.
- Knowledge about fermentation protocols for production of microbial biomass such as edible yeasts, mushrooms, single cell proteins and single cell oils. The student also learns about production of microbial carotenoid pigments such as lycopene and β-carotene.
- To know microbes causing food intoxications and food-borne infections.
- Know traditional food preservation techniques, chemical preservation and irradiation.
- Is able to utilize modern techniques viz. high-pressure processing (HHP), bacteriocins, manosonication (MS) and pulsed electric field (PEF) for effective food preservation. The student can also calculate kinetics of inactivation, process and product parameters.
- Gain knowledge about conventional methods for food quality analysis and is able to use the most recent and non-invasive techniques of quantification and detection of food borne microbes and pathogens such asESS and various new imaging techniques.
- Understands the relevance of microbial standards for food safety, quality assurance programs that revolutionize food safety.

Pedagogy:

Food microbiology is a sub-discipline of Microbiology which focuses on the study of the microorganisms that ferment, inhibit or contaminate food. It also includes the study of microorganisms that cause food spoilage and those with other useful roles.

The course emphasizes basic concepts of food microbiology, contamination and food spoilage, dairy microbiology, food poisoning and intoxication, food produced by microbes, detection of food borne microorganisms and microbial indicators of food safety quality control, food law and legislation.

The study encompasses food borne diseases of microbial origin, microbial food spoilage, beneficial uses of microbes in food, control of microbial growth in foods, destruction of microbes in foods, microbial food fermentation, pro-biotic bacteria, regulatory aspects to ensure consumers related to microbial hazards in food.

The lecture will impart students with knowledge, how microorganisms are useful to produce food, how they contaminate, spoil and cause diseases and how to detect their presence in the food. The knowledge gained about food microbiology helps the students to develop interest in this field and helps the students to work in the food industries that are interested in isolation, detection of food borne pathogens and production of food products from microorganisms.

Course Content

UNIT-I **12 Hr**

Introduction to food microbiology: Definition, concepts and scope. Food as substrate for microbes. Factors influencing microbial growth in food-Extrinsic and intrinsic factors. Principles of food preservation- Chemical preservatives and Food additives Asepsis-Removal of microorganisms, (anaerobic conditions, high temperatures, low temperatures, drying).Canning, processing for Heat treatment.

UNIT-II

Contamination and food spoilage: Cereals, sugar products, vegetables, fruits, meat and meat products, Fish and sea foods- poultry- spoilage of cannedfoods.

Dairy Microbiology: Microbiology of raw milk, Milk as a vehicle of pathogens, Prevention of contamination of raw milk, Microbiology of processed milk, Spoilage and defects fermented milk and milk products, Microbiological standards for milk and milk products. Cream and butterbacteriology.

UNIT-III **12 Hr**

Food poisoning and intoxication: Significance of food borne diseases, Staphylo Food poisoning and intoxication: Significance of food borne diseases, Staphylococcal, Gasteroenteritis and enterotoxins: Types and incidence, Prevention of Staphylococcal and other food poisoning syndromes, *Clostridium perfringens*food poisoning and Botulism, *Bacillus cereus* food poisoning, Food borne Listeriosis by *Listeria monocytogenes*, Food borne Gastroenteritis by *Salmonella* and *Shigella, Vibrio, Campylobacter* and *Yersinia*, fungal spoilage and Mycotoxins.

Food produced by Microbes: Microbial cells as food (single cell proteins) – mushroom cultivation. Bioconversions- production of alcohol-fermented beverages-beer and wine.Genetically modified foods.

UNIT-IV **12 Hr**

Detection of food-borne microorganisms: Culture, Microscopic and Sampling methods.. Chemical: Thermostable nuclease *Limulus* Lysate for Endotoxins, Nucleic Acid (DNA) probes, DNA Amplification (PCR), Adenosine- Triphosphate Measurement, Radiometry, Fluoro-and Chromogenic substrates. Immunologic Methods: Fluorescent Antibody, Enrichment Serology, Salmonella 1-2. Test, Radioimmunoassay, ELISA.

Microbial indicators of food safety and quality control: Principles of quality control and microbiological criteria, Indicators of product quality and microbiological safety of foods, Hazard analysis, critical control points (HACCP), Good manufacturing process (GMP) Microbiological standards Codex Alimentarius and Foodlegislation.

References:

1. Adams M. R. and Moss M. O. 2007. Food Microbiology 3rd Edition. Royal Society of Chemistry.UK.
2. Ahmed E.Y. and Carlstrom C. 2003 Food Microbiology: A Laboratory Manual, John Wiley and Sons, Inc. NewJeresy.
3. Bibek Ray, ArunBhunia. 2013. Fundamental Food Microbiology, Fifth Edition. CRCPress
4. C Blackburn.2006. Food Spoilage Microorganisms. WoodheadPublishing.
5. Dongyou Liu. 2009. Molecular Detection of Foodborne Pathogens. CRCPress.
6. Elmer H. Marth, James Steele. 2001. Applied Dairy Microbiology, Second Edition. CRCPress.
7. Frazier W.C. and Westhoff C.D. 2008 Food Microbiology. Tata McGraw Hill Publishing Company Limited, New Delhi. IndianEdition.
8. Jay, James M., Loessner, Martin J., Golden, David A. 2004.Modern Food Microbiology. 7th ed. Springer
9. Marshall, Richard J. (Ed.). 2007. Food Safety.Springer.
10. Pina M. Fratamico, Arun K. Bhunia, and James L. Smith. 2008. Foodborne Pathogens: Microbiology and Molecular Biology. Caister AcademicPress.
11. Pitt, John I., Hocking, Ailsa D. 2009. Fungi and Food Spoilage 3rd Edition.Springer.
12. Sperber, William H., Doyle, Michael P. (Eds.). 2010. Compendium of the Microbiological Spoilage of Foods and Beverages.Springer.
13. Stephen J. Forsythe. 2010. The Microbiology of Safe Food, 2nd Edition.Wiley-Blackwell.

Course-IV: SOIL MICROBIOLOGY **48 Hr**

Course Outcome:

- Students will learn that the soil is an excellent habitat for multitude of microorganisms balancing the soil ecosystem.

- The knowledge acquired in Soil Microbiology will enhance the students' competency in the performance of their duties as future employees in the field of Agronomy/Soil Science.
- Attainment of course objectives will mean realization of the various beneficial effects of soil microorganisms on soil health, which is instrumental in the production of food and fiber. Conversely, students learned that some soil microbes are deleterious to agronomic crops
- Students will learn that some soil animals and what they eat are of ecological importance; thus, planteating insects and mollusks may add organic matter to the soil; insects, arachnids,

  and worms that consume dung and plant litter mix it with soil and speed up its decay; and, plant parasitic nematodes reduce soil's productivity.

Pedagogy:

Soil microbiology is the study of all microorganisms that exist in the soil, specifically the ways they function and affect soil properties. Our soils are pulsating with life, serving as excellent hosts for the growth and development of various organisms. In fact, there are more microbes in one teaspoon of soil than there are people on the planet. This collection of organisms consists of bacteria, fungi, and algae that serve many vital roles in the overall nourishment of soils.
Bacteria are largely responsible for the process of nitrogen fixation; converting atmospheric nitrogen into compounds that can be used by plants. Although not as commonly abundant as bacteria, fungi also assist with extremely significant functions of soil health. While one of their main activities is decomposition of organic matter, fungi also perform necessary services related to water and nutrient cycling. Fungi are responsible for binding soil particles together, assembling a system to increase water filtration and water holding capacities. In a similar manner as fungi, earthworms also break down organic matter, such as dead leaves, and produce natural fertilizers. They too support soil fertility with the transportation of water throughout the soil, as well as air.

Course content

UNIT-I

Soil Microbiology: Historical accounts and the "Golden Age" of soil microbiology and significant contributions of pioneer soil microbiologists.**Soil Microbial diversity**: Diversity and abundance of dominant soil microorganisms, Methods of isolation of soil microflora, soil organic matter decomposition.

Unit-II **12 Hr**

Biogeochemical cycles: carbon, sulphur and iron cycles in soil.
Soil microbe interaction - Antagonism, commensalism, mutualism, symbiosis, predators and parasite relationship and competition.Interaction of soil microflora with vascular plants - Rhizosphere, rhizoplane microorganisms, *Rhizobium, Azatobacter, Azospirillum, Cyanobacteria* and *Azolla.*

Unit-III **12 Hr**

Applied soil microbiology: soil microbial inoculants, Manipulations of soil microorganisms for agriculture, Soil environmental contaminants and Bioremediation, Microbial products- Plant growth promoting Hormones, Antibiotics, Toxins and Enzymes

Unit-IV **12 Hr**

Soil-Borne Diseases and Human Health: *Clostridium tetani*(tetanus), Toxoplasmosis, Aspergillosis, Actinomyces.

Soil microorganisms in agro ecosystems: Types of microbial communities; soil microbial

diversity: significance and conservation; effect of agricultural practices on soil organisms. Biological nitrogen-fixation: The range of nitrogen fixing organisms; mechanism of nitrogen fixation (biochemistry of nitrogenase); genetics of nitrogen-fixation; *Rhizobium*-Legume Association; Symplasmids, N2 fixation by non-leguminousplants.

References:

1. Agrios, G. N. 2000. Plant pathology. Harcourt Asia Pvt.Ltd.
2. Bergersen, F.J. and Postgate, J.R. 1987. A Century of Nitrogen Fixation Research Present Status and Future Prospects. The Royal Soc.,London.
3. Buchanan, B.B., Gruissem, W. and Jones, R.L. 2000. Biochemistry and Molecular Biology ofPlants.
   I.K. International Pvt. Ltd.
4. Burges, H.D. 1981. Microbial control of insect pests, Mites and plant diseases. Academic,London.
5. Dixon, R.O.D. and Wheeler, C.T. 1986. Nitrogen Fixation in plants. Blackie USA, Chapman and Hall, NewYork.
6. Kannaiyan, S. 1999. Bioresources Technology for sustainable agriculture. Assoc. Pub. Co. New Delhi.
7. Mehrotra, R.S. 2000. Plant pathology. Tata McGraw-Hill Publishing CompanyLimited.
8. Metcalf, R.L. and Luckmann, W.H. 1994. Introduction to insect pest management 3ed edn. John Willey and Sons,Inc.
9. Motsara, I.M.R., Bhattacharyya, P. and Srivastava, B. 1995. Biofertilizer Technology, Marketing and usage-A source Book-cum- glossary- FDCO, New Delhi.
10. Somasegaran,PandH.J.Hoben,1994.HandbookforRhizobia;methodsinlegum eRhizobium Technology. Springer-Verlan, New York.

PRACTICAL-III (Microbial Physiology and Immunology)

1. Population growth of yeast – *S.cerevisiae*.
2. Population growth of bacteria – *Ecoli*.
3. Sugar fermentation tests.
4. Catalaseactivity.
5. Hydrolytic rancidity.
6. Casein hydrolysis.
6. Carbohydrate catabolism bymicrobes
7. Study of acid and pH stress tolerance bymicrobes.

8. Effect of molecular oxygen on microbialgrowth.
9. Effect of osmotic pressure on microbialgrowth.
10. Effect of relative humidity on microbialgrowth.
11. Effect of different wavelengths of light on microbialgrowth.
12. Immunological Methods used for organism detection – production of antibodies for use in laboratory testing.
13. Serological Diagnosis of Infectious diseases – Serologic testMethods.
14. Precipitin test, ELISA, OuchterlonyImmunodifusion test, Immunoelectrophoresis, Complement fixation test.
15. Isolation of Antigens and raising antibodies from animals (from different Models),
16. Development of polyclonal antibodies, purification ofantibodies.
17. WIDALTest.
18. VDRL Test(RPR).
19. HBs AgTest.
20. HCG test (Agglutination inhibitiontest).
21. Detection of RAfactor.
22. CRP test.
23. ASO Test (Anti streptolysin 'O'Test).

PRACTICAL-IV (FOOD AND DAIRY MICROBIOLOGY)

1. Bacterial examination of drinking water by membrane filtertechnique.
2. Study of important microbes in the degradation ofwastes.
3. Determination ofTDT.
4. Determination ofTDP.
5. Detection and quantification of AflatoxinB1.
6. Detection of food-borne bacteria byimmunoassays.
7. Detection and enumeration of Microorganisms present inUtensils.
8. Isolation and identification of pathogenic microorganisms from canned food.
9. Enumeration of bacteria in raw and pasteurized milk by SPCmethod.
10. Determination of quality of a milk sample byMBRT.
11. Detection of number of bacteria in milk by breed-countmethod
12. Litmus milktest.
13. Microbial quality of milkproducts.
14. Microbiological examination of Ice-cream and Dairyproducts
15. Soil microbes interaction *In vitro* by dual culturemethod
16. Isolation, identification and enumeration of Rhizosphere and Rhizoplanemicroorganism
17. Isolation of *Rhizobium* from roots of leguminous plant.

OPEN ELECTIVE

COURSE –VII: **MICROBIAL DIVERSITY** **48 Hr**

Course Outcome:

- To gain insights into common groups of bacteria and archaea in different ecosystems, and their role in biogeochemical key processes in these environments.

- To understand cultivation-independent methods for studies of the composition of microbial communities and for the function and occurrence of individual groups.

- Genomic and meta genomic based methods to study microbial diversity in nature
- To understand interactions within microbial communities and between microorganisms and plants and animals.
- Use bioinformatic tools and databases that are used to study microbial diversity.
- Acquire a fairly good understanding of the Diversity of the microbes and activities/importance of microbes.; practical skills of handing microorganisms in the laboratory for study

Pedagogy:

Microbial diversity is a sub discipline of microbiology focuses on the huge diversity of microbes, its interaction with the ecosystem. Such interactions are essential for ecosystem function and may relate to plant and animal health, biogeochemical cycles and numerous other processes.

Overall this course enables students to learn how the microbial world rules over the entire ecosystem focusing on their interactions which form the basis of survival. The study helps us improve our lives via the use of microbes in environmental restoration, food production, bio-engineering of useful products such as antibiotics, food supplements and chemicals.

The knowledge gained under this subject helps the students to work in laboratories like pharmacological industries, clinical health and diagnostic laboratories, environmental research fields, microbial research and any industry where microorganisms and involved. The need of the hour is to focus on the importance of conservation of microbial diversity mainly the role of culture centers in conservation.

COURSE CONTENT

UNIT-I **12 Hr**

Viral Diversity: Morphology, ultra structure, chemical composition of virus, classification of viruses, Group I – T2 Bacteriophage, Group II – Banana bunchy top virus, Group III – Reovirus, Group IV- TMV, Group V – Rhabdovirus, Group VI – HIV, Group VII – Hepatitis virus.

Sub-viral particles: Discovery, Structure, Classification, replication and diseases caused by Satellite, Satellites virus, Virusoids, Viroids and Prions.

UNIT-II **12 Hr**

Bacterial Diversity: Archaebacteria, Photosynthetic Eubacteria, Chemoautotrophic and Methophilic Eubacteria, Gliding Eubacteria, Spirochetes, Rickettsiae and Chlamydiae, Actinomycetes, Mollicutes, Protists. Classification based on Bergey's manual (Determinative & Systematic).

UNIT-III **12 Hr**

Fungal Diversity: Classification, Distribution, Importance, Structure, reproduction and general characteristics of the fungal divisions: Zygomycota (*Rhizopus*), Ascomycota

(*Neurospora*), Basidiomycota (*Agaricus*), Deuteromycota (*Penicillium*), Chytridiomycota (*Allomyces*) , Myxomycota and Yeast.

UNIT-IV **12 Hr**

Importance and Conservation of Microbial Diversity: Importance of microbial diversity in agriculture, forestry, environment, industrial & food biotechnology, animal & human health. Metagenomics. Importance of conservation. *In situ* conservation and *Ex situ* conservation. Role of culture collection centers in conservation.

References

1. Alexopoulos, C. J. and Mims, C. W. 1979. Introductory Mycology. III edition, Wiley Eastern, New Delhi.
2. Dimmock, N. J., Easton, A. J. and Leppard, K. N. 2001. Introduction to Modern Vorology. 5th edn. Blackwell publishing,USA.
3. Ghosh, A. 2003. Natural Resource Conservation and Environment Management. Aph Publishing Corp.Calcutta.
4. Landecker, E. M. 1972. Fundamentals of Fungi. Prentice-Hall, Angelwood Cliff, NewJersey.
5. Madigan M.T., Martinko M. J. and Parker, J. 2003. Brock Biology of microorganisms. Pearson education., NewJercy.
6. Pelczar, (Jr.) M. J., Chan, E. C. S. and Kreig, N. R.1993. Microbiology. McGraw Hill, NewYork
7. Perry, J.J. and Staley, J.T. 1997. Microbiology. Dynamics and Diversity. 4th edn. Wesley Longman pub. NewYork.
8. Presscott, L. M., Harley, J. P. and Klein, D. A. 1999. Microbiology. 4th edn. WCB McGraw- Hill, NewDelhi.
9. Satyanarayana, T. and Johri, B. N. 2005. Microbial Diversity – Current Perspectives and Potential Applications. I K Int. Pvt. Ltd. New Delhi.
10. Stainer, R. Y., Ingraha, J, L, Wheelis, M. L. and Painter, P. K. 1986. General Microbiology. McMillanEdun. Ltd.London.
11. Stanley J.T. and Reysenbach A.L.1977. Biodiversity of microbial life. John Wiley 7 Sons Inc.Publication. NewYork.
12. Wagner, E.K. and Hewlett, M.J. 1999. Basic Virology. Blackwell Science.Inc.

THRID SEMESTER

HARDCORE

COURSE-1: MOLECULAR BIOLOGY **48Hr**

Course Outcome:

- Understand the structure of DNA and RNA, organization of eukaryotic/prokaryotic genome, replication, , transcription, Mutations and DNA repair
- Insights into gene regulation in both prokaryotic and eukaryotic organisms
- Is able to describe post-transcriptional processes, RNA editing, RNAi and miRNA
- Is able to describe translation mechanism in prokaryotes and eukaryotes, regulation of translation, and post-translational processing
- Is able to describe post-translational processes.

Pedagogy:
Molecular biology is the root branch of biology which deals with biomolecules, it's modifications and other molecular level mechanisms occurring in the body of living organisms. This field is developed out of related fields like genetics, biochemistry, biophysics and microbiology. Molecular biology gives a wide information on basic concepts of DNA structure and replication, DNA damage and recombination, synthesis of proteins by transcription, translation and regulation of gene expression in bacteria, bacteriophage, eukaryotes. Each unit is well presented with basic descriptions of cellular mechanisms of both prokaryotes and eukaryotes. In this discipline the major interest is drawn towards the differences in the molecular mechanisms in prokaryotes and eukaryotes.

The students view is synchronized into the world of biomolecules for the better understanding of molecular mechanism, cell to cell interaction, cell replication, mutations. This discipline allows the students to understand the molecular mechanisms so that they can study the cause of evolutionary existence of life and also the various diseases that result due to the changes in the biomolecules.

COURSE CONTENT

UNIT-I **12Hr**

Concepts in Molecular Biology: Microbes in molecular biology.
Organization of Genomes: Prokaryotic genome- Genetic and Physical organization of bacterial genome, Eukaryotic genome – Genetic and Physical organization of nucleargenome **DNA structure and Replication:** DNA as Genetic material, Chemistry of DNA, Modes of DNA Replication, Enzymes of DNA replication, Molecular mechanism of DNA replication, Differences in prokaryotic and eukaryotic DNA replication.

UNIT-II **12Hr**

DNA damage and recombination: Types of DNA damage - deamination, oxidative damage, alkylation and pyrimidine dimers; DNA repair – mismatch, short patch repair, nucleotide/base, excision repair, recombination repair and SOS repair. Molecular basis of mutation, Recombination; Site specific recombination, Homologous recombination, transposition

UNIT-III **12Hr**

Gene Expression: Structure of RNA- Classes of RNA, Chemistry of RNA.
Transcription: Transcription in prokaryotes and eukaryotes, Eukaryotic transcription factors. RNA processing, Ribozymes, Antisense RNA, Inhibitors of transcription and their mechanism of action.
Translation: Role of ribosome and different types on RNA in protein synthesis, basic feature of genetic code, mechanism of initiation, elongation and termination, Translational control and posttranslational events.

UNIT-IV **12Hr**

Regulation of Gene expression: Regulation of gene expression in prokaryotes and Eukaryotes. Regulation of gene expression in bacteriophages, gene silencing – gene regulation after transcription.

References:

1. Benjamin, L. 1990. Gene 4th edn. Oxford Univ. Press,Oxford.
2. Brown, T. A. 1991. Essential Molecular Biology. A Practical Approach Vol-I & Vol.-II, Oxford Univ. Press.Oxford.
3. Flint, S.J., Enquist, L.W., Drug, R.M., Racaniello, V.R. and Skalka, A.M. 2000.Principles of Virology- Molecular Biology, Pathogenesis and Control. ASM Press, Washington,D.C.
4. Garrett and Grisham. 1999. Biochemistry. 2nd edn. Saunders college pub.USA.
5. Hartl, D.L. 1994. Genetics. Jones and Bartler Publishers,London.
6. Lewin, B. 2000. Genes VII. Oxford Univ.Press.
7. Lodish, H., Berk, A., Zipursky, S. A., Matsudaira, P., Baltimore, D. and Darnell, J.1999.
8. Molecular Cell Biology, W.H. Freeman and Company, New York.

COURSE-II: GENETIC ENGINEERING **48Hr**

Course Outcome:

- Students will become familiar with the tools and techniques of genetic engineering DNA manipulation enzymes, genome and transcriptome analysis and manipulation tools, gene expression regulation, production and characterization of recombinant proteins.
- This course exposes students to the applications of genetic engineering in biological research.
- Students will be able to perform basic genetic engineering experiments at the end of course.
- Students will acquire knowledge of advances in biotechnology- healthcare, agriculture and environment cleanup via recombinant DNA technology.
- Given the impact of genetic engineering in modern society, the students should be endowed with strong theoretical knowledge of this technology. In conjunction with the practicals in molecular biology & genetic engineering, the students should be able to take up biological research as well as placement in the relevant biotech industry

Pedagogy:

Genetic Engineering is an inter-disciplinary subject of biology which focuses on gene manipulation techniques using living systems and the applications of manipulated genes. This course helps students learning the components, techniques of gene manipulation in organisms and use of these techniques to create novel products(vaccines, enzymes GMOs).

The contents of the course are divided into four units. Each unit focuses on tools, techniques used in gene manipulation, applications of recombinant DNA, ethics concerned with gene manipulation and bioinformatics. Overall, this course teaches students the importance and scope of genetic engineering in the current world.

The lecture will impart knowledge of using these techniques in various fields such as agriculture to create transgenic plants, in therapeutics or medicine to create vaccines, to cure genetic diseases. In industries to increase efficiency of production of various microbial products, in forensic science to identify suspects, paternity issues etc., this subject has wide scope and great significance in the world.

COURSE CONTENT

UNIT-I **12Hr**

Introduction to Genetic Engineering: Historical perspectives and milestones in Recombinant DNA Technology. Importance of gene cloning and future perspectives.

Tools in Genetic Engineering: Enzymes in genetic engineering. Cloning vectors: Ti Plasmid, pBR322, pUC –series. Phage vectors-M13 phage vectors, Cosmids-Types, Phasmids or Phagemids, Shuttle vectors. YAC and BAC vectors, Adenovirus vector, Synthetic construction of vectors, Ti cloningvector

UNIT-II **12Hr**

rDNA Technology: The basic principles of gene cloning strategies: Preparation, Manipulation and Insertion of desired DNA into vector. Introduction of DNA into host cells – Transformation, Transduction, Transfection, Microinjection, Biolistics, Electroporation, Liposome fusion. Shotgun cloning.Genomic and c-DNA Libraries.Cloning and expression in bacteria, yeasts, Identification and Selection of recombinants.

UNIT-III **12Hr**

Analysis of gene and gene products: Isolation and purification of nucleic acids, staining, Molecular markers in genome analysis: RFLP, RAPD, AFLP and ISSR analysis, DNA sequencing. Blotting techniques- Southern, Northern and Western blotting techniques. PCR –principles, types, and applications.

Introduction to Bioinformatics and Molecular Databases, Primary Databanks – NCBI, EMBL, DDBJ; Secondary Databases – UNIPROT; Structural Database –PDB; Database similarity search (FASTA, BLAST); Alignment: Pairwise and Multiple sequence alignment; Genome Annotation and Gene Prediction; Primer Designing; Phylogenetics analysis and Tree construction; Protein Sequence Analysis; DNA microarrays. DNA sequencing methodology – Sangers dideoxymethod.

UNIT-IV **12Hr**

Applications of gene cloning and Ethics in Genetic Engineering: Applications of gene cloning in Biotechnology, Medicine, Agriculture, Forensic Science, Antisense technology. RNAi and Gene silencing, Gene therapy.

Safety of recombinant DNA technology: Restriction and regulation for the release of GMOs into Environment. Ethical, Legal, Social and Environmental Issues related to rDNA technology.

References:

1. Brown, T.A. (2010)Gene Cloning and DNA Analysis-An Introduction 6thedn. BlackwellScience.
2. Brown, T.A. (2011) Introduction to Genetics: A Molecular Approach 1stEd.
3. Setlow, Jane K. (2004) Genetic Engineering: Principles and Methods.Springer.
4. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger(2007) Molecular Cell Biology 6thEd.
   W.H. Freeman and Company, New York.
5. Alexander N. Glazer, Hiroshi Nikaido(2007) Microbial Biotechnology Fundamentals of Applied Microbiology 2nd Ed. Cambridge UniversityPress
6. H.-J. Rehm, G. Reed. (2008) Biotechnology: Genetic Fundamentals and Genetic Engineering, Volume 2, Second Edition.Wiley.
8. Desmond, S. T. and Nicholl. (2002) An Introduction to Genetic Engineering. Cambridge Univ. Press. Cambridge
9. Maheshwari, D.K., Dubey, R.C. and Kang, S.C.(2006) Biotechnological Applications of Microorganisms. I.K. International Publishing House. NewDelhi.
10. P. K. Gupta. (2008) Molecular Biology and Genetic Engineering. Deep and Deep Publications.India.
11. VK Gupta, MSchmoll, M Maki, MTuohy, MAMazutti. (2013) Applications of Microbial Engineering. CRCPress.

COURSE-III: INDUSTRIAL MICROBIOLOGY 48Hr

Course Outcome:

- Get equipped with a theoretical and practical understanding of industrial microbiology
- Appreciate how microbiology is applied in manufacture of industrial products
- Know about design of bioreactors, factors affecting growth and production, heat transfer,oxygen transfer
- Understand the rationale in medium formulation & design for microbial fermentation, sterilization of medium and air
- Appreciate the different types of fermentation processes
- Understand the biochemistry of various fermentations
- Identify techniques applicable for improvement of microorganisms based on known biochemical pathways and regulatory mechanisms
  Comprehend the techniques and the underlying principles in downstream processing.

Pedagogy:

Industrial microbiology is a branch of applied microbiology. Which deals with the microorganisms and fermentation technology used for production of high value added products such as therapeutic agents, fuels, food items, chemicals, sweeteners, detergents, beverages, enzymes, vitamins, and proteins. The course imparts detailed fundamental principles and of industrial microbial processes.

The course contained four units and focuses on basic industrial equipment's, isolation and screening of microorganisms, media formulation, production and key factors for optimum maintenance, recovery process and production economics, commercial value

and their applications. The course provides the basic knowledge of the industrial processes and biosynthesis of potent microbial agents.

This course makes the students as entrepreneurs and gives so many jobs for the people, and helps the students to work in the pharmaceutical, chemical, food ,beverages and dairy industries and biotechnological sectors includes biomedical, bio prospecting and biomass industries.

Course Content

UNIT-I **12Hr**

Introduction: Fermenter design and types of fermenters, achievement and maintenance of aseptic conditions, Types of fermentation processes (Surface, submerged, Batch, Continuous, solid-substrate, Dual, Fed batch fermentation and its applications),

Industrial Microorganisms: Screening, Isolation. Identification and characterization ofindustrially important microbes. Strain improvement- mutation, recombination- gene regulation and genetic manipulation. Preservation of industrially important microbes. Culture collection centers.

UNIT-II **12Hr**

Media for Industrial Fermentations: Media formulation, growth factors, carbon, nitrogen, Energy and Mineral sources, buffers, inhibitors, precursors, inducers, Oxygen requirements Antifoam agents and others, Sterilization: Sterilization of bioreactor, media, air and exhaust air and filter sterilization

Downstream processing and fermentation economics: Steps in recovery and purification Methods of cell separation – filtration and centrifugation, cell disruption, liquid liquid extraction, chromatography, membrane processes. Fermentation economics- expenses for industrial organisms, strain improvement, media sterilization, heating, cooling, aeration and agitation. Cost of Plant and equipments, batch process cycle time, continuous culture, recovery and effluent treatment, cast recovery due to waste usages and recycling.

UNIT-III **12Hr**

Industrial production of energy fuels: Industrial alcohol production: Biosynthesis, methods of production, recovery and applications of ethanol, acetone – butanol and glycerol through microbial process.

Industrial production of Organic acids and Enzymes: biosynthesis, media, production process, product recovery and application of citric acid and lactic acid, Enzymes: Fungal and Bacterial Amylase; Bacterial proteases.

UNIT-IV **12Hr**

Industrial production of food additives: amino acid production, methods of production, product recovery of L-Glutamic acid and L-lysine. Commercial uses of Amino acids Vitamins: Commercial production of Vitamin B_{12}, and Riboflavin. Alcoholic beverages (Beer, Wine,)

Industrial production of health care product: Industrial production of β-lactum antibiotic

(Penicillin): Biosynthesis, production and recovery. Streptomycin. Biosynthesis, production and recovery.Antitumor and anticholesterol agents, SCP and SCO, I P R: Patent Laws: Patent regulations of processes, products and microorganisms.

References:

1. Barsanti, L and Gualtieri, P. 2005. Algae: Anatomy, Biochemistry, and Biotechnology. Taylor and Francis NewYork.
2. Casida, L.E. 1997. Industrial Microbiology. New Age InternationalPublishers.
3. Crueger, W. and Crueger, A. 2003. Biotechnology- A text book of Industrial Microbiology. PanimaPublishingcorporation.
4. Demain, A. L. 2001. Industrial Microbiology and Biotechnology IInd Edition. ASM Press, Washington.
5. Demain, A.L. and Davies, J.E. 1999. Manual of Industrial Microbiology and Biotechnology IInd Edition. ASM Press,Washington.
6. El-Mansi, E.M.T. and Bryce, C.F.A. 2004. Fermentation Microbiology and Biotechnology. Taylor and FrancisGroup.
7. Horton, H.R., Moran, L. A., Scrimgeour, K.G. Perry, M.D and Rawn, J.D. 2006. Principles of Biochemistry, IVth Edition. Pearson Education Internationl.London.
8. Julian E Davies and Arnold L Demain 2009 Manual of Industrial Microbiology and Biotechnology ASM Publisher
9. Maheshwari, D.K., Dubey, R.C. and Saravanamtu, R. 2010. Industrial Exploitation of Microorganisms. I.K. International Publishing House. NewDelhi.
10. Mansi El-Mansi, C. F. A. Bryce. 2007. Fermentation microbiology and biotechnology. CRCPress.
11. Michael J Waites , Neil L Morgan , John S Rockey , Gary Higton 2009. IndustrialMicrobiology
12. NdukaOkafor 2010. Modern Industrial Microbiology and Biotechnology ASMPublisher
13. NupurMathurAnuradha 2007 Industrial Microbiology A LaboratoryManual.
14. Patel A H: 2008 Industrial Microbiology: PBBooks.
15. Patel, A. H. 1999. Industrial Microbiology, McMillan India Limited,India.
16. Peppler, H.J. and Perlman, D. 1979. Microbial Technology. Academic Press, NewYork.
17. Peppler, H.J. and Perlman, D. 2005. Microbial Technology: Fermentation Technology Second Edition Volume 1. Elsevier India PrivateLimited.
18. Peppler, H.J. and Perlman, D. 2005. Microbial Technology: Fermentation Technology Second Edition Volume 2. Elsevier India PrivateLimited.
19. Puri, R.S. and Viswanathan, A. 2009. Practical Approach to Intellectual Property Rights. I.K. International Publishing House. New Delhi.
20. Raymond Bonnett 2010 Wine Microbiology and Biotechnology CRCpress
21. Reed. G. 1999. Prescott and Dunn's Industrial Microbiology. CBS Publishers andDistributors.

Course-IV: MEDICAL MICROBIOLOGY **48Hr**

Course Outcome:

- This course provides knowledge regarding basic principles of medical microbiology and infectious disease.
- It covers mechanisms of infectious disease transmission, principles of aseptic practice, and the role of the human body's normal microflora
- It also provides opportunities to develop informatics and diagnostic skills, including the use and interpretation of laboratory tests in the diagnosis of infectious diseases.
- To understand the importance of pathogenic bacteria in human disease with respect to infections of the respiratory tract, gastrointestinal tract, urinary tract, skin and soft tissue and the methods to control diseases, e.g. chemotherapy & vaccines.

Pedagogy

Medical microbiology, the large subset of microbiology that is applied to medicine, is a branch of medical science concerned with the prevention, diagnosis and treatment of infectious diseases. In addition, this field of science studies various clinical applications of microbes for the improvement of health. It is the study of microbes, such as bacteria, viruses, fungi and parasites, which cause human illness and their role in the disease.

Clinical microbiology laboratories perform aerobic and anaerobic bacteriology, parasitology, mycobacteriology, mycology, and virology. Clinical microbiology is also a rather complex discipline because it utilizes many different types of methodologies and constantly undergoes changes in testing methods. Methods used to diagnose microbial diseases, and the microbiology laboratory may comprise several disciplines (e.g., classical culture methods, antigen detection methods, molecular methods, and serological methods are often performed under the purview of microbiology). The wide variety of pathogens and testing methods that are available makes microbiological testing challenging. In the clinical microbiology laboratory, as in every other discipline, the frequency of analytical errors has been reduced considerably with the implementation of quality control and quality assurance programs.

COURSE CONTENT

UNIT-I **12Hr**

Introduction to Medical Microbiology: History, Development and scope of Medical Microbiology. Concept of Disease, disorder, syndrome, Communicable diseases-Microbial infections and diseases. Factors responsible for microbial pathogenicity.

Microbial infections: Types of infections, modes of transmission, portal of entry: Urinary tract infection, sexually transmissible infection, Infection of the central nervous system, Infections of circulatory system, Oral cavity and respiratory infection, gastrointestinal infection.

UNIT-II **12Hr**

Nosocomial infection: Incidence of nosocomial infections, types of nosocomical infections, emergence of antibiotic resistant microorganisms, hospital infection control programmes, preventing nosocomial infections and surveillance, General concepts for specimen collection and handing of specimen, specimen processing and biosafety.

Chemotherapeutic agents: antibiotics (Classification based on chemical structure, mode of action and range of effectiveness). Recent trends-Drug resistance and its consequences, antibiotic policy, NCCLS (CLSI) guidelines and standards, WHO guidelines.

UNIT-III **12Hr**

Epidemiology, Pathogenesis, Spectrum of disease, Laboratory diagnosis and Prevention: Diseases caused by Viruses: Chicken pox, Rabies virus, hepatitis, encephalitis, AIDS, Herpes simplex infections, Influenza, Dengue

Diseases caused by Bacteria: Tuberculosis, Leprosy, Cholera, Typhoid, Botulism, Shigellosis, Helicobacter pylori infection, Salmonellosis, Tetanus. Diseases caused by Fungi: Candidiasis, Histoplasmosis, Blastomycosis, Coccidiomycosis, Dermatomycosis, Aspergillosis and Cryptococcosis, Anthrax

UNIT-IV **12Hr**

Diseases caused by Mycoplasma: *Mycoplasma pneumoniae, M. urealyticum,M.homonis.*

Diseases caused by Protozoa: Giardiasis, Trichomoniasis, CelebralMalaria,Toxoplasmosis, Cryptosporidium.

Disease caused by Chlamydiae: Psittacosis, LymphogranulomaVenereum, Trachoma and Inclusion conjunctivitis.

Emergent Diseases: Hemorrhagic fever, Swine flu, SARS, Chikungunya, Ebola, Hanta, Leptospoirosis, Marburg

References:

1. Robert W. Bauman Ph.D. (2011) Microbiology with Diseases by Body System (3rd Edition);BenjaminCummings
2. Patrick R. Murray PhD, Ken S. Rosenthal PhD, Michael A. Pfaller MD (2012) Medical Microbiology;Saunders
3. Brooks, Geo F., Carroll, Karen C., Butel, Janet S. (2012) JawetzMelnick&Adelbergs Medical Microbiology ; McGraw-Hill Medical PublishingDivision
4. Kenneth Ryan, C. George Ray , Nafees Ahmad , W. Lawrence Drew, Michael Lagunoff ,Paul Pottinger, L. Barth Reller, Charles R. Sterling (2014) Sherris Medical Microbiology, Sixth Edition; McGraw-HillMedical
5. Robert W. Bauman Ph.D. (2011) Microbiology with Diseases by Body System (3rd Edition); BenjaminCummings
6. Timothy JJ Inglis (2013) Clinical Microbiology and Infectious Diseases; Point of CarePublications
7. Patricia Tille (2013) Bailey & Scott's Diagnostic Microbiology; Mosby Marjorie Kelly Cowan (2012) Microbiology Fundamentals: A Clinical Approach; McGraw-HillScience/Engineering/Math
8. Connie R. Mahon , Donald C. Lehman , George Manuselis Jr. (2010) Textbook of Diagnostic Microbiology ;Saunders
9. Ananthanarayan ,Paniker(2009)Textbook of Microbiology , 8th Edition; UniversityPress
10. Jawetz (2010)Medical Microbiology ,25th Edition; Tata McGraw - HillEducation

COURSE-V: CLINICAL & DIAGNOSTIC MICROBIOLOGY 48Hr

Course Outcome:

- Various bacterial, viral, fungal and protozoal disease their causative agent, mode of infection, epidemiology, treatment, lab diagnosis, prophylaxsis.
- students will develop skill regarding Isolate and identify microorganism form laboratory sample,
- Antibiotics senstitivity and resistance test
- Detection of parasite
- Handling of blood and body fluids

Pedagogy:

Clinical and Diagnostic Microbiology is a specialty within the sciences which focuses on applying microbiology to medical application. Similarly to being concerned with the identification of a disorder-inflicting organism, diagnostic microbiology can also be a part of modifying a treatment plan. Microbes including bacteria, protozoans, and fungi play a vital factor in many disease processes. The various laboratory techniques like microscopy, immunological assessments, radiology, biomarker tests, ELISA, serology checks, vaccines vectors are the primary diagnostic tests which are currently in use. Many microbes have developed resistance to medications. Hence, it's far essential for the scientists to give smarter methods of diagnosing those microbes and their pathogenic mechanisms.

Course Content

UNIT-I **12Hr**

Introduction to clinical Microbiology: Role of Microbiologist in Diagnostic laboratory, General concepts for specimen collection, handling, transportation, processing, specimen workup, Laboratory safety and infectioncontrol.

Scientific and Laboratory basis for Clinical/Diagnostic Microbiology: Microscopic examination of infectious diseases, Growth and biochemical characteristics, Rapid methods of identification.

UNIT-II **12Hr**

Immunotechniques and Immunodiagnosis: Antigens and Antibody reactions *in vitro;* Agglutination, complement fixation, ELISA, Western Blotting Immunodiffusion, Immunoelectrophoresis, Immunoflurescence, Immunoprecipitation, Radioimmunoassay andserotyping.

Vaccines and Vaccination: Vaccines – definition, types, Antigens used as Vaccines, effectiveness of vaccines, Vaccine safety, current vaccines, adjuvants, active immunization and passiveimmunization.

UNIT-III **12Hr**

Recent Diagnostic tools and techniques: Principle, working and application of a) Autoanalyser b) Biosensor glucometer c) Diagnositic kits- ELISA, Western Blot

Enzymes in Disease diagnosis and therapy: Lactate dehydrogenase, Aspartate aminotransferase, Alkaline phosphatase, Creatine kinase, Acid phosphotase, Cholinesterase.

UNIT-IV **12Hr**

Antimicrobial Chemotherapy: Development of chemotherapy; General characteristics of drugs and their testing; Mechanism of action. Antibacterial drugs; antifungal drugs, antiviral and antiprotozoan drugs; antibiotic sensitivity testing, MIC, Drug resistance; mechanism of drug resistance; multi drug resistance.

Reference

1. GouraKudesia (2009) Clinical and Diagnostic Virology. Cambridge University Press.UK.
2. J. Andre Knottnerus and Frank Buntinx (2008) The Evidence Base of Clinical Diagnosis: Theory and Methods of Diagnostic Research, 2nd Edition. WileyPublication.
3. Huggett and Justin O'Grady *LGC (2014)* Molecular Diagnostics: Current Research and Applications. Caister AcademicPress.
4. Vinay Kumar et al., (2010) Robbins and Cotran pathologic basis of disease. Philadelphia, PA: Saunders/Elsevier.
5. Richard A. McPherson and Matthew R. Pincus (2011). Henry's clinical diagnosis and management by laboratory methods. (22nd Edi) Philadelphia, PA :Elsevier/Saunders,
7. Alberto M. Marchevsky and Mark Wick. (2011). Evidence Based Pathology and Laboratory Medicine. Springerpublication.
8. David E. Bruns; Edward R. Ashwood; Carl A. Burtis; Barbara G. Sawyer (2007). Fundamentals of Molecular Diagnostics St. Louis, Mo. : Saunders Elsevier
9. Stephen B. Hulley; Steven R. Cummings; Warren S. Browner; Deborah G. Grady; Thomas B. Newman (2007) Designing clinical research (3rd edition). Philadelphia, PA: Lippincott Williams & Wilkins.
10. HuwLlewelyn , Hock AunAng, Keir E Lewis and Anees Al-Abdullah (2009). Oxford Handbook of Clinical Diagnosis. Oxfordpublications.
11. Peter Hu MadhuriHegde and Patrick Alan Lennon (2012). Modern Clinical Molecular Techniques. Springerpublications.
12. HenrikWinther and Jan T. Jorgensen (2010). Molecular Diagnostics. Springerpublications.
13. Prakash S. Bisen, MousumiDebnath and GBKS Prasad (2010) Molecular Diagnostics: Promises and Possibilities. Springerpublications

PRACTICAL V (Molecular Biology and Genetic engineering)

1. Isolation of Genomic DNA from *E. coli*.
2. Determination of purity and concentration of isolated DNA usingspectrophotometer
3. Separation of proteins by SDSPAGE.
4. Salt fractionation of Yeast protein andquantification.
5. Isolation of plasmids from bacteria by agarose gelelectrophoresis.
6. Estimation ofDNA
7. Estimation ofRNA
8. Estimation of protein by Lowry'smethod

9. Digestion of the gene of interest with suitable restrictionenzymes.
10. Ligation of the digested gene in avector.
11. Preparation of competent *E. coli* cells for Bacterialtransformation.
12. Transformation of the vector into the host cell and selection of the desiredclones.
13. Induction of gene expression and purification of the induced protein from thehost.
14. Amplification, Purification and separation of PCRproduct.
15. Determination of DNase activity on isolatedDNA.
16. Determination of RNase activity on isolatedRNA.
17. Determination of Proteinase activity onproteins.

PRACTICAL VI (Industrial and Medical Microbiology)

1. Study design of Fermentor andParameters
2. Isolation of antibiotic/ amino acid/organic acid producing microbes and theirpreservation.
3. Batch fermentation of Citric acid production, recovery and estimation of citricacid.
4. Production of any vitamin and its quantification bybioassay.
5. Antibiotic fermentation and estimation ofpenicillin.
6. Preparation of wine and estimation of alcohol by specific gravitymethod.
7. Alcoholic fermentation and determination of total acidity and non-reducingsugars
8. Preparation of banana juice usingPectinase
9. Pathogenic fungi of the skin(Dermatophytes).
10. Microbial flora of mouth – teeth crevices.
11. Microbial flora ofsaliva.
12. Microorganisms of respiratory tract-examination of sputum/ AFB acid – fastbacteria.
13. Estimation of bacteria in urine by calibrated loop direct streakmethod.
14. Antimicrobial assay – sensitivity test (MIC) for pathogenicbacteria.
15. Laboratory diagnosis of important human diseases: Diphtheria, Tuberculosis, Typhoid, Wound infections, Malaria, Leprosy, AIDS andHepatitis.

OPEN ELECTIVE

Course-VIII : MICROBIAL TECHNOLOGY **48Hr**

Course Outcome:

- To acquire knowledge on food product analysis
- To enable them to know about preservation of pharmaceutical products
- Learn to assess the microbial quality of marine foods Outcome
- Acquire Knowledge on food product analysis
- Impart knowledge of preservation technology.
- Knowledge on quality analysis of marine food products

Pedagogy:

It is a sub-discipline of Microbiology which focuses on microbiological techniques or methods used for the study of microbes, including bacteria, fungi and protists. This course helps students learning fundamental procedures and safety guidelines followed in the microbiology laboratory.

This course teaches students the basic skills necessary to be successful in the laboratory as well as provides easy to follow, step-by-step, directions on how to perform each technique based in microbiology. The lecture will impart the students with knowledge and skills about how to culture, stain, identify, preserve and control of microorganisms. The skills and knowledge gained about techniques in microbiology helps the students to work in the laboratories like food and dairy industries, pharmacological industries, clinical, health and diagnostics laboratories, and any industries where microorganisms are used.

COURSE CONTENT

UNIT-I **12Hr**

Microscopy: Light microscopy- Simple microscopy (dissection microscope), Compound microscopy (Bright field, Dark field, phase contrast, and Fluorescence microscopy) and stereomicroscopy. Electron microscopy: Principles, construction and mode of operation of scanning and Transmission electron microscopy, limitations. Preparation of specimens for electron microscopic studies (Ultra-thin sectioning, negative staining, shadow casting and freeze etching).

UNIT-II **12Hr**

Microbiological stains and staining techniques: Types of stains and principles of staining. Stains for bacteria, fungi, algae and protozoa, spirochetes, stains for azotobacter cysts, stains for mycoplasma. Preparation of bacterial smears for light microscopy: Fixation, simple staining, Differential staining, Structural staining (Capsule, Flagella, Cell wall and Endospore of bacteria), and nuclear staining.

UNIT-III **12Hr**

Culture media for Microbes Types of media- general purpose media, special purpose mediaselective, elective, diagnostic, resustication media, Media for fungi, algae, bacteria, mycoplasma andviruses.

Sterilization techniques: Principles, types of Sterilization, and their mode of action. Physical methods: Heat-dry heat (Hot-Air oven), Incineration, Moist heat (Autoclave and Pressure cooker), Tyndalization (Fractional Sterilization), Filtration-Types of filters, Laminar airflow. Radiation methods (UV radiation, x- rays and cathoderays).

UNIT-IV **12Hr**

Control of Microorganisms: Chemical methods: Definition of terms- Disinfectants, Antiseptics, Sanitizers, Microbicides (bactericide, fungicide and Sporicide),

Microbistatic (bacteristatic and fungi static agents). Use and mode of action of Alcohols, Aldehydes, Halogens, Phenols, Heavy metals, andDetergents.

Pure culture techniques: Different types of inoculation techniques - Spread plate, Pour plate and Streak plate methods

References:

1. Alcomo, I.E. 2001. Fundamentals of Microbiology. VI Edition, Jones and Bartlett Publishers, Sudbury,Massachusetts.
2. Aneja, K.R. 1993. Experiments in Microbiology, Plant Pathology. Rastogi and Company,Meerut.
3. Cappuccino, J. G. and Sherman, N. 1999. MICROBIOLOGY A Laboratory Manual 4th Edn. Addison –Wesley.
4. Becker, W. M., Kleinsmith, L.J. and Hardin, J. 2000. The world of the Cell. IVth Edition. Benjamin/Cummings.
5. Kango. N. 2010. Textbook of Microbiology. I.K. International Publishing House. NewDelhi.
6. Madigan M.T., Martinko M. J. and Parker,J. 2003. Brock Biology of microorganisms. Pearson education., NewJercy.
7. Pelczar, (Jr.) M. J., Chan, E. C. S. and Kreig, N. R.1993. Microbiology. McGraw Hill,NewYork
6. Perry, J.J. and Staley, J.T. 1997. Microbiology. Dynamics and Diversity. 4th edn. Wesley Longman pub. NewYork.
7. Perry, J.J., Staley, J.T. and Lory, S. 2002. Microbial Life. Sinauer Associates, Publishers, Sunderland,Massachusetts.
8. Presscott, L. M. Harley, J. P. and Klein, D. A. 1999. Microbiology, International edn. 4th edn. WCB McGraw-Hill.
9. Schaechter, M. Ingraham, J.L. and Neidhardt, F.C. 2006. Microbe. ASM Press,Washington.D.C.
10. Stainer, R. Y., Ingraha, J L, Wheelis, M. L. and Painter, P. K. 1986. General Microbiology. McMillanEdun. Ltd.London.
11. Stanley J.T. and Reysenbach A.L.1977. Biodiversity of microbial life. John Wiley 7 Sons Inc. Publication. NewYork.
12. Sullia, S.B. and Shantharam,S. 2000. General Microbiology (Revised) Oxford & IBH Publishing Co. Pvt.Ltd.
13. Talaro, K and Talaro, A.1996. Foundations in Microbiology, II edition, WCBpublishers.
14. Tortora, G.J., Funke, B.R. and Case, C.L. 2004. Microbiology-An Introduction. Benjamin Cummings. SanFrancisco.

FOURTH SEMESTER
HARDCORE

Course-I: AGRICULTURAL MICROBIOLOGY **48Hr**

Course Outcome:

- Approaches used in agriculture to control disease in plant
- Microbial ecology and microbial interaction
- Pathogenic interactions with plant

- Microbial biocontrol agents

Pedagogy:

Agricultural microbiology is a branch of microbiology dealing withplant associated microbes.It also deals with microbiology of soil fertility, such as microbial degradation of organic matter and soil nutrient transformations. It aims to address problem in agricultural practices usually caused by lack of biodiversity in microbial communities.

An understanding of microbial strains relevant to agricultural applications is useful in the enhancement of factors such as soil nutrient, plant pathogen resistance, crops robustness fertilization uptake effectively. The many symbiotic relationship between plant and microbes can ultimate be exploited for greater food production necessary to feed expanding new population safer to minimize the ecological disruption. The microbes are also used as bio fertilizers, bio pesticides, and fungicides. Agricultural microbiology also explains about the plant pathogen and the control measures. The use of techniques for the proper harvest and storage of the crops and its prevention from the contamination by microorganisms.
The syllabus includes four disciplines which deal with the introduction to agricultural microbiology, the plant pathology, parasitism and disease development, the defense mechanism of plant, plant disease and their management, the microbes and plant interaction and the bio pesticides.

Course Content

UNIT-I **12Hr**

Introduction to Agricultural Microbiology:, Introduction to agricultural microbiology, concepts and scope of agricultural microbiology, Agronomy and production of important crop plants, Green revolution. Plant Pathology: Concept of disease, History of Plant Pathology, Significance of plant diseases, Symptoms and types of plantdiseases.

Plant Pathology in Practice: Plant Clinic and Plant Doctor Concept. Diagnosis of Plant Diseases – Infectious diseases, Non-infectious diseases, Kochs'rules;

UNIT-II **12Hr**

Parasitism and Disease Development Parasitism and pathogenecity, Host range of pathogens, Disease triangle, Diseases cycle / Infection cycle, Relationship between disease cycles and epidemics; Pathogens Attack Plants – Mechanical forces, Microbial enzymes and toxins, Growth regulators. Effect on physiology of Host – Photosynthesis, Translocation and transpiration, Respiration, Permeability, Transcription and translation.Environment and Plant Disease– Effect of Temperature, Moisture, Wind, Light, Soil, pH and structure, Nutrition and Herbicides.

Defense Mechanisms of Plant: Disease Pre-existing structural and chemical defenses, Induced structural and biochemical defenses. Microbe mediated strategies for abiotic stressmanagement.

UNIT-III **12Hr**

Plant Disease & their management: Tobacco Mosaic Disease, Sandal Spike Disease, Bacterial blight of Paddy, Citrus canker, Angular leaf spot of cotton, Late Blight of

Potato, Downy Mildew of Bajra, Blast of paddy, Tikka disease of ground nut, Rust of coffee, Grain and Head smut of Sorghum. Powdery mildew of Cucurbits, Wilt of Tomato, and Root Knot of Mulberry. Bunchy top of Banana.

UNIT-IV **12Hr**

Microbes and Plant interaction-Mycorrhizae-Biology and their applications, Biofertilizers - microbial inoculants. Production and application of *Rhizobium, Azospirillum, Azotobacter,* phosphor bacteria and Cyanobacteria.PGPR's plant growth promoting *Rhizobacteria*and their uses.

Biopesticides: Definition, types-bacterial, viral, fungal and protozoan, mode of action, target pests, use of transgenic plants. mode of action, Bacteria-endo and ecto-toxins production by *Bacillus thuringiensis, and Pseudomonas.* Fungi- *Beauveria, Cephalosporium,* and*Trichoderma.*

References:

1. George. N. Agrios (2005),Plant pathology, Elsevier academic press, 5th edition,U.K.
2. Mehrotra. R.S. and Ashok Aggarwal (2002), Plant pathology, Tata MC Graw-Hill publishers, 2nd edition,Delhi.
3. Kannaiyan. S. (2002), Biotechnology of Biofertilizers, Alpha science international, 1st edition.
4. Bagyaraj D.G. and Rangaswami. G. (2005). Agricultural Microbiology, Prentice- Hall of India, 2nd edition, NewDelhi.
5. NeelimaRajvaidya and Dilip Kumar Markandey. (2006). Agricultural Applications of Microbiology, Nangia S.B. and A.P.H. publishing corporation, New Delhi.
6. Oerke, E.C. Dehne, H.C. Schönbeck, F.Weber, A. (1999). Crop Production and Crop Protection, Elsevier academic press, 5th edition, U.K.
8. Roger Hull (2013).Plant virology, Elsevier academic press, 1th edition,U.K.
9. Hermann H. Prell, Peter R. Day. (2001). Plant-Fungal Pathogen Interaction: A Classical and Molecular View, 1st edition, Springer-Verlag Berlin Heidelberg,Germany.
10. Geoffrey Clough Ainsworth (1981). Introduction to the History of Plant Pathology 1st edition, Cambridge university press,U.K.
11. Vidhyasekaran, P. (2007). Fungal Pathogenesis in Plants and Crops: Molecular Biology and Host Defense Mechanisms, 2nd edition, APS press,U.S.A

SOFTCORE

COURSE -II: ENVIRONMENTAL MICROBIOLOGY **48Hr**

Course Outcome:

- Will have an overview of the till date developments in the field of environmental microbiology with special emphasis on the role of microbes in mitigating environment pollution.
- Will have become acquainted with various cultural, biochemical and molecular techniques used in understanding microbial diversity.
- Will be knowledgeable about the diversity, adaptations and biotechnological applications of microbes of extreme environment.
- Is able to describe the role of microbes in solid and liquid waste management, gaining knowledge of various methods employed in sewage treatment and solid waste treatment.
- Understands the role of microbes in bioremediation of environmental pollutants like petroleum hydrocarbons, pesticides, plastic and electronic waste; also understands utility of microbes in mineral and oil recovery.

Pedagogy:

Microbial communities control nutrient cycles and biogeochemical transformations in natural, managed and engineered ecosystems. Microorganisms recycle organic matter, transform contaminants, and maintain ecosystem health. Understanding the ecology of natural microbial communities will deepen our understanding of how ecosystems function. Since microbial communities are critical for ecosystem function, microbial ecology can also assist the development of models to predict how ecosystems will respond to future environmental conditions.

Environmental Microbiology introduces students to the diversity of microbial populations and their important roles in environmental processes in air, water, soils, and sediments. Microbial community ecology and interactions with plants and animals will also be discussed. Students will learn how microbial activities sustain natural ecosystems Techniques for characterizing microorganisms and investigating microbial processes will also be discussed. The lectures impart knowledge to utilize bio wastes from industrial and agricultural fields. This recycling of bio wastes leads to costless and environment clean .

COURSE CONTENT

UNIT-I **12Hr**

Air Microbiology: Airspora of indoor and outdoor environment, factors affecting airspora, Techniques of trapping air borne microorganisms.

Aquatic Microbiology: Distribution of microorganisms in the aquatic environment, Water pollution sources, Biological indicators of water pollution, Determination of sanitary quality of water, Waste water microbiology-Primary, secondary, tertiary treatment and reclamation of waste water

UNIT-II **12Hr**

Soil Microbiology: Characteristics and classification of soil. Interactions between microorganisms: Mutualism, commensalism, ammensalism synergism, parasitism, predation, competition. Rhizosphere, rhizosphere, microflora and its beneficial activity.Role of microorganism in nitrogen, phosphorous and sulphur cycle.Detrimental effects of diverted biogeochemical cycles. Biological nitrogen fixation in detail:

Symbiotic, asymbiotic and associated nitrogen fixation. Structure, function and genetic regulation of nitrogenases. Viable but nonculturable bacteria.

UNIT-III **12Hr**

Microbes in extreme environment: Microbes of extreme environments, Thermophiles, acidophiles, alkaliphiles, halophiles. barophiles and their survivalmechanisms.

Space microbiology: Historical development of space microbiology, Life detection methods

a) Evidence of metabolism (Gulliver) b) Evidence of photosynthesis (autotrophic andheterotrophic).

UNIT-IV **12Hr**

Microbes in the degradation of wastes: Treatment of solid and liquid industrial wastes, Microbial degradation of pesticides, Xenobiotics, degradation of lignin, cellulose and pectin. Bioremediation. Geomicrobiology: Microbes in metal extraction, mineral leaching and mining, copper extraction by leaching and microbes in petroleum product formation. Global Environmental Problems: Global Warming, Acid rain, Ozone depletion. Bio deterioration of wood and metals.

COURSE-III: GENOMICS AND PROTEOMICS **48Hr**

Course Outcome:

- The aim of this course is to teach genomics, transcriptomics, proteomics,metabolomics and phonemics using model organisms representing plants and animals.
- The course will cover recent developments in genomics, gene expression and small RNAs, synthetic biology, epigenetics, proteomics, fast-forward genetics and next-generation mapping.
- An objective of the course is to develop skills in experimental design within the context of learning about biology including: regulation of transcription and translation, stress response, signal transduction and the engineering and regulation of metabolic pathways.

Pedagogy:

Genomics is the study of entire genomes, including the complete set of genes, their nucleotide sequence and organization, and their interactions within a species and with other species. The advances in genomics have been made possible by DNA sequencing technology. Genomic information is used to create similar maps of the DNA of different organisms. *Proteomics* generally refers to the large-scale experimental analysis of proteins and proteomes

Bioinformatics helps the students to understand Genomics and proteomics which uses the computational knowledge to extract the knowledge from biological database. This helps in data analysis, visualization, prediction, primer designing, data storage etc., through web based tools like NCBI. Students are able to understand and use the knowledge of bioinformatics and do Insilco analysis to verify and test their hypothesis

before they start their wet lab experiments. Bioinformatics helps in drug discovery and students will be placed in pharmaceutical and drug companies.

COURSE CONTENT

UNIT-I **12Hr**

Genome - Overview Of Genome; Sequence Of Genome Acqusition And Analysis - Homologies - Snps - Genetic Analysis, Linkage Mapping, High **Resolution Chromosome Mapping And Analysis** - Physical Mapping, Yac, Hybrid Mapping, Strategies, Sequence Specific Tags (Sst), Sequence Tagged Sites(Sts), Ish, Fish, Rflp,Rapd.

UNIT-II **12Hr**

DNA Sequencing - Methods, MaxamAnd Gilbert Method, Ladder, Fluorescent, Shot Gun, Mass Spectrometry, Automation Sequencing – Find Gene Mutations, Implications of DNA – Sequencing And Sequencing Genomes.

Genome Data Bank, Metabolic Pathway Data - Construction And Screening Of cDNA, Libraries And Microarrays - Application Of DNA Arrays - PCR - Variations In PCR - Gene Disruptions – Sage And Sade, Pharmacogenomics.

UNIT-III **12Hr**

Protein Sequence Analysis - Introduction - Sequence Data Banks - Wbrf – Pir - Swissport - Databases, Data Mining - Algorithms Of Proteomics And Its Applications - Protein Expression

Profiling - Protein - Protein Interaction - Protein Modifications. Automation - Nucleic Acid Data Bank – EMBL Nucleotide Sequence Data Bank - Aids Virus Sequence Data Bank - RNA DataBank.

UNIT-IV **12Hr**

Tools For Data Bank - Pairwise Alignment - Needleman And WuschAlgorighm – Smith Waterman - Multiple Alignment - Clustral - Pras - Blast - Fast, Algorithms To Analyse Sequence Data - Pdb, Cambridge Structure Data Base (Lsd), 2d Electrophoresis, Ief, Hplc, Protein Digestion Technique, Mass Spectrometry, Maldi, Tof, Peptides, Mass Finger, Printing,Protein.

References

1. Lynn Jorde , Peter Little , Mike Dunn and Shankar Subramaniam (2014). Encyclopedia of Genetics, Genomics, Proteomics and Bioinformatics. Wiley Publication.UK
2. Suhai, Sándor (2002). Genomics and Proteomics. Springerpublications.
3. Nawin Mishra (2010). Applications of Proteomics I: Proteomics, Human Disease, and Medicine. Wiley publication.UK
4. Ganapathy Subramanian and Nawin Mishra (2012). Science of Proteomics: Historical Perspectives and Possible Role in Human Healthcare. Wiley Publications.UK

5. FerencDarvas, AndrásGuttman, GyörgyDormán (2013). Chemical Genomics and Proteomics (2nd Ed). CRCPress.
7. Ruchi Singh (2014). BIOINFORMATICS: GENOMICS AND PROTEOMICS. Vikas Publications. New Delhi.
8. MetinAkay (2007). Genomics and Proteomics Engineering in Medicine and Biology. Wiley Publications. UK.
9. DevarajanThangadurai and JeybalanSangeetha (2015). Genomics and Proteomics Principles, Technologies, and Applications. Apple AcademicPress.
10. Malcolm Campbell, Laurie J. Heyer (2003). Discovering genomics, proteomics and bioinformatics. Benjamin Cummings publications.
11. Nachimuthu Saraswathy and Ponnusamy Ramalingam (2011). Concepts and Techniques in Genomics and Proteomics .Woodhead Publishinggroups.
12. R.S. Dassanayake, Y. I. N. Silva Gunawardene (2011). Genomic and Proteomic Techniques: In Post Genomics Era. Narosa Book Distributors.

COURSE-IV: PRACTICAL VII (Agricultural Microbiology &Environmental Microbiology)

1. Isolation, culturing and seed inoculation of *Rhizobium* and testing of nodulation ability and beneficial effects.
2. Isolation and testing the efficiency of various biofertilizers like *Rhizobium, Azotobacter, Azospirillum.*
3. Mass multiplication techniques of *Azolla.*
4. Estimation of total phenols in diseased and healthy plant tissues.
5. Seed health testing by SBM.
6. Collection and Identification of following disease: Tobacco mosaic disease, Bunchy top of Banana, Bean Mosaic, Sandal spike, Bacterial blight of paddy. Citrus canker, Downy mildew of Bajra, Powdery mildew of mulberry, Head smut of sorghum, Leaf rust of coffee, Blast disease of paddy, Tikka disease of groundnut, Leaf spot of paddy and Grassy shoot of sugarcane.
7. Isolation and identification of micro flora of soil, sewage and air
8. Microbes as indicators of water pollution – Determination of indices of water quality.
9. Determination of BOD of pollution water.
10. Determination of COD of polluted water.
11. Degradation of cellulose by *Chaetomiumglobosum.*
12. Bacterial examination of drinking water by membrane filter technique.
13. Study of associated soil microorganisms with plants, Actinorhiza, Mycorrhiza.
14. Study of important microbes in the degradation ofwastes.
15. Isolation of cellulose degraders, chitinase and pesticide degraders
16. Determination of TS and MLSS

UNIVERSITY OF MYSORE

(Re-accredited by NAAC with 'A' Grade)
(NIRF-2023: Ranked 44 in University Category & 71 in Overall Category)
DEPARTMENT OF STUDIES IN MICROBIOLOGY

Proceedings of the BOS Meeting of Microbiology (CB)

As per the direction of the Registrar, University of Mysore, Mysuru, Board of Studies Meeting of Microbiology (CB) of University of Mysore was conducted on 10/06/2024 at Department of studies in Microbiology, Manasagangotri, University of Mysore, Mysuru. The information about the discussion carried out in the meeting is enclosed with this letter. The details of the BoS members who participated.

Sl.No	Name of the Bos Member	Designation	Signature
1.	Prof. M.Y. Sreenivasa	Chairman	
2.	Prof. Shubha Gopal	Member	10/6/24
3.	Prof. K. Ramachandrakini	Member	10/6/24
4.	Prof. V. Shyam Kumar	Member	10/6/24
5.	Prof. Virupakshaiah . DBM	Member	10/6/24
6.	Prof. Srinivas C	Member	Attended Online
7.	Dr G. S Siddegowda	Member	10/6/24
8.	Dr. H S. Jayanth	Member	10.6.24
9.	Dr. N.S. Devaki	Member	10/6/2024
10.	Dr. N.Anuroopa	Member	Absent
11.	Dr. P.K. Maheshwar	Member Special Invitee	

UNIVERSITY OF MYSORE

(Re-accredited by NAAC with 'A' Grade)

(NIRF-2023: Ranked 44 in University Category & 71 in Overall Category)

DEPARTMENT OF STUDIES IN MICROBIOLOGY

Details of the Discussion & Decisions Taken at BoS Meeting of Microbiology (CB)

1. The Chairman BoS in Microbiology welcomed the BoS members and placed the BoS Meeting Agenda before the members.
2. Discussed and approved the changes in the course of B.Sc., Microbiology syllabi and Scheme of examination 2024-2025
3. Discussed and approved the course of M.Sc., Microbiology syllabi and Scheme of examination 2024-2025
4. Prepared and approved of Question paper pattern & scheme of Practical Examination 2024-2025
5. Prepared and approved the Panel of examiners for UG & PG examinations 2024-2025
6. Any other Matter:
   - Opinion regarding: Guide Recognition to Dr. Ragavendra M P, Professor, Maharani,s Science College, Mysuru (Ref.No.Dor/9.5/Ph.D/ROG-Mic/18/14/2024-25 Dtd:10-6-2024)
   - Decision: The member approved the Guide Recognition to Dr. Ragavendra M P.
7. The BoS meeting is concluded with the vote of thanks by the Chairman.

10/6/24 10/6/24 10/6/24 10/6/24 10/06/24 10/6/24 10/6/24 10/6/24

UNIVERSITY OF MYSORE, MYSURU

CHOICE BASED CREDIT SYSTEM (CBCS)

&

CONTINUOUS ASSESSMENT AND GRADING PATTERN (CGPA)

Based

M. Sc. MICROBIOLOGY SYLLABUS

For

2024-25 onwards

Board of Studies in Microbiology
Department of Studies in Microbiology
University of Mysore
Manasagangotri, Mysuru 570 006
Karnataka, India

Introduction

Microbiology is an important and wide-ranging discipline within the life sciences, covering a range ofsubjects relevant to human health, diseases, environmental studies and industrial and biotechnologicalapplication. Microbiology has vast scope in understanding the life through intervention of microorganism.There is an increase in demand for microbiologist globally. A microbiologist can innovate new diagnostickits, teach, research, discover new drugs etc., it encompasses many disciplines of science like medicine,diaryagriculture pharmacynanotechnologyetc.,

KnowledgeandskillsinMicrobiologythatwillempowerthestudents,throughawarenessofthesignificance of microorganisms in plant, animal and human health, environment, industry and generalhuman welfare by a problem based and skill-oriented curriculum. The syllabus is highly oriented towardsthe complete knowledge of the subject, which includes the basic as well as contemporary applied aspectsofMicrobiology includingmolecularbiologyand geneticengineering.

ProgramPedagogy:

The seminar presentation will improve the oration skills of students and group discussion will kindle theirlogical ability to analyze the problems**.** Assignments improvise students in gathering the information andenhancing their writing ability. In practical laboratory they will be enhancing their skills towards varioustechniques used in the laboratory. As a part of curriculum, students work on project, which will give ahands-on experience on different techniques and will be a platform for the students to work and interactwith different scientists and research institutions. This will pave the way for the students to know aboutrecentresearchworksgoing oninthefieldandhelpthestudent in workingindifferentamenities.

Programoutcome:

- Thestudentsgettoknowaboutdifferentbeneficialandharmfulmicroorganisms,whichmightbeuseful /pathogenictohumans,animalsandplants.
- Microbiologyisconcernedwithdiversifiedformsofmicroorganism,classification,structure,reproduction,physiology,metabolismandmostimportantlytheir economicimportance.
- Industrial productions of organic acids, enzymes and pest control using microbes and improving soilqualityandagriculturaloutputandcleaningthe environment throughsustainablemicrobiologicalapplications.
- Toenablethemtoemploytheacquiredtheoreticalknowledgeinthesectorof Diseasediagnosis,treatment and prevention.
- To enrich the post graduate students with fundamentals of microbiology and advanced technologies,which enables them use this knowledge in industry, hospitals, community and institutes or any otherprofessionthey wouldliketopursue.

Programspecificoutcome:

Understand the basic knowledge and concepts of microbiology and other related areas. Hands on skills inIndustry and/or Institutes, for better placement in drug manufacturing companies, public health entities,bloodservice,industriallaboratories,cancerresearchinstitutes,R&D,educationalinstitutes,environmental pollution control, agriculture and fisheries, food and dairy industry, forensic science,hospitals, public health laboratories, etc. There is requirement for microbiologist in quality control andsafetysections of food, pharmaceuticals, health andbeautycare, etc.

SCHEME OF THE STUDY

For M.Sc. in Microbiology

Credits to be earned	40 credits
Core papers	28 credits
Open elective paper	04 credits
Total credits	**72 credits**

Honors in Microbiology

Credit Based Choice Based Continuous Evaluation Pattern System Proposed Semester-wise distribution of the course structure for the year 2024-2025

Semester-I Credits: 18

No	Paper Code	Title of The Course Paper	Credit Pattern in L:T:P	Credits
1	**MB 1.1 Hard core**	Virology	3:1:0	4
2	**MB 1.2 Hard core**	Bacteriology	3:1:0	4
3	**MB 1.3 Hard core**	Mycology	3:1:0	4
		Select 3 among 4 papers		
4	**MB 1.4 Soft core**	Microbial Genetics	3:0:0	2
5	**MB 1.5 Soft core**	Microbial Ecology & Diversity	3:0:0	2
6	**MB 1.6 Soft core**	Practical I (Virology & Bacteriology)	0:0:2	2
7	**MB 1.7 Soft core**	Practical II (Mycology & Microbial Genetics)	0:0:2	2
		Total credits to be earned		**18**

HC=03; SC=03; O.E=0.

Semester-II Credits: 18

No	Paper Code	Title of The Course Paper	Credit Pattern in L:T:P	Credits
1	**MB 2.1 Hard core**	Microbial Physiology	3:1:0	4
2	**MB 2.2 Hard core**	Immunology	3:1:0	4
		Select 3 among 4 papers		
3	**MB 2.3 Soft core**	Food Microbiology	3:0:0	2
4	**MB 2.4 Soft core**	Soil Microbiology	3:0:0	2
5	**MB 2.5 Soft core**	Practical III (Microbial Physiology & Immunology)	0:0:2	2
6	**MB 2.6 Soft core**	Practical IV (Food Microbiology)	0:0:2	2
7	**MB 2.7 OE**	Techniques in Microbiology	4:0:0	4
		Total credits to be earned		**18**

HC=02; SC=03; O.E=1.

M.Sc. Microbiology

Credit Based Choice Based Continuous Evaluation Pattern System Proposed Semester wise distribution of the course structure

Semester-III Credits: 18

No	Paper Code	Title of The Course Paper	Credit Pattern in L:T:P	Credits
1	**MB 3.1 Hard core**	Molecular Biology	3:1:0	4
2	**MB 3.2 Hard core**	Genetic Engineering	3:1:0	4
3	**MB 3.3 Hard core**	Industrial Microbiology	3:1:0	4
		Select 3 among 6 papers		
4	**MB 3.4 Soft core**	Medical Microbiology	3:0:0	2
5	**MB 3.5 Soft core**	Clinical & Diagnostic	3:0:0	2
6	**MB 3.6 Soft core**	Practical V (Molecular Biology & Genetic Engineering)	0:0:2	2
7	**MB 3.7 Soft core**	Practical VI (Industrial Microbiology & Medical Microbiology)	0:0:2	2
8	**MB 3.8 Soft core**	MOOCS/ SWAYAM	2:0:0	2
9	**MB 3.9 OE**	Microbial Diversity	3:0:0	2
		Total credits to be earned		**18**

HC=03; SC=03; O.E=01.

Semester-IV Credits: 18

No	Paper Code	Title of The Course Paper	Credit Pattern in L:T:P	Credits
1	**MB 4.1 Hard core**	Agricultural Microbiology	3:1:0	4
2	**MB 4.2 Hard core**	Environmental Microbiology	3:1:0	4
		Select 3 among 7 papers		
3	**MB 4.3 Soft core**	Microbial Nanotechnology	4:0:0	4
4	**MB 4.4 Soft core**	Genomics & Proteomics	4:0:0	4
5	**MB 4.5 Soft core**	Practical VII (Agricultural Microbiology)	0:0:2	2
6	**MB 4.6 Soft core**	Practical VIII (Environmental Microbiology)	0:0:2	2
7	**MB 4.7 Soft core**	Practical IX (Microbial Nanotechnology)	0:0:2	2
8	**MB 4.8 Soft core**	Project Work	0:0:6	6
9	**MB 4.9 Soft core**	MOOCS/ SWAYAM	2:0:0	2
		Total credits to be earned		**18**

HC= 02; SC=03

Grand Total Credits: 72

SEMESTERI

MB1.1Hardcore: VIROLOGY

CoursePedagogy:

- Knowledgeonhistory,generalcharactersofvirusesandviralclassification
- Understandingthereplicationstrategiesofviruses;Cultivationanddetectionofviruses.
- Comprehendevolutionaryimportanceofviruses.
- Knowledgeonsomecommonplantandanimaldiseasescausedbydifferentviruses,viraltransmissionandcontrol.

CourseOutcome:

Afterthe completion ofthe coursestudentswould beable

- Tostudy thenatureofviruses.
- Techniquesemployedforculturinganddetectionofplantandanimalviruses
- Togainknowledgeabout neweremergingviral
- Tounravelthemechanismsby whichviruses infectcells andcausedisease.
- Virusesusedas cloningvectorsforgenetransfer,therapeuticagents.

THEORY **48 hours**

UNIT I **12 hours**

Viral Diversity: Classification – LHT, Baltimore & ICTV; and nomenclature of viruses. Replication patterns of the following groups; Group I – T2 Bacteriophage, Group II – Banana bunchy top virus, Group III – Reovirus, Group IV-TMV, Group V – Rhabdovirus, Group VI – HIV and Group VII – Hepatitis B virus. Microbial viruses: General account on algal, fungal, protozoan viruses, Giant viruses and Bacteriophages.

UNIT II **12 hours**

Plant viruses: Propagation, Cultivation, Isolation and purification using centrifugation, chromatography and electrophoresis techniques. Detection and diagnosis of Plant Viruses **Cultivation and detection of animal viruses**: Animal Inoculation, Inoculation into embryonated egg and CellCulture. Direct methods of detection- light microscopy (inclusion bodies), electron microscopy (SEM, TEM, AFM and Cryo EM) and fluorescence microscopy. Immunodiagnosis: hemagglutination and hemagglutination inhibition test, compliment fixation, neutralization, western blot, flow cytometry. Nucleic acid based diagnosis: nucleic acid hybridization, PCR, qRT, Microarray and nucleotide sequencing. **Infectivity assay for animal and bacterial viruses:** Plaque assay, Transformation assay, Fluorescent focus assay, Infectious centre assay, end point dilution methods, LD50, ID50, EID50, TCID50.

UNIT III **12 hours**

Sub-viral particles: Discovery, Structure, Classification, replication and diseases caused by Satellite virus, Virusoids, Viroids and Prions. Anti-viral strategies-prevention and control of viral diseases: Host specific and nonspecific defense mechanisms. Role of interferon in viral infections.

Viral Chemotherapy: Nucleoside analogs, reverse transcriptase inhibitors, protease inhibitors. **Conventional viral vaccines**: killed and attenuated vaccines, Modern vaccines: peptide vaccines, edible vaccines, immune-modulators (cytokines),anti-idiotype, DNA and m-RNAvaccines.

UNIT IV **12 hours**

Viral transformation and oncogenesis: Oncogenic viruses and viral transformation mechanism by EBV, HPV, and HTLV-1. **Viruses and the future**: Promises and problems. Evolutionary importance of viruses: Antigenic shift, antigenic drift. Emerging and life threatening diseases – COVID-19 and variants, KFD virus, and ZIKA. Sources and causes of emerging viral diseases. Viruses as threat of bioterrorism, as therapeutic agents, as gene delivery system, viruses to destroy other viruses.**Virus and nano-technology.**

References:

1. AlanJ.Cann (2011)Principles ofMolecular Virology,5th edition, Elsevier
2. Clokie,MarthaR.J., Kropinski,Andrew(2009)Bacteriophages,Methodsand Protocols,Volume1:Isolation,Characterization, andInteractions, HumanaPress
3. EdwardK.Wagner,MartinezJ.Hewlett,DavidC.Bloom,DavidCamerini(2007),BasicVirology, 3rdEdition,John Wiley&Sons.
4. Hunter-Fujita,FrancesR.,PhilipF.Entwistle,HughF.Evans,and Norman E.Crook.Insectviruses andpestmanagement. JohnWiley & Sons Ltd1998.
5. Jane S. Flint , Lynn W Enquist, Anna Marie Shalka (2004) Principles of Virology: Molecular Biology,Pathogenesis,and Control of AnimalViruses, American SocietyforMicrobiology
6. John Carter, Venetia A. Saunders,(2007),Virology: Principles and Applications, John Wiley & Sons,westSusscex,England.
7. Lobocka,Malgorzata, andWaclawT.Szybalski,eds.(2012)Bacteriophages.Part2,AcademicPress
8. Marc H.V. van Regenmortel, Brian W.J. Mahy (2009) Desk Encyclopedia of General Virology, Iedition,AcademicPress.
9. Matthews,RichardEllisFord,andRogerHull.(2002)Matthews'plantvirology.4thedition,GulfProfessional Publishing.
10. Moulay Mustapha Ennaji (2020), Emerging and Reemerging Viral Pathogens: Volume 1: FundamentalandBasicVirologyAspects ofHuman, Animaland Plant Pathogens1st Edition.AcademicPress.
11. Nigel Dimmock, Andrew Easton, Keith Leppard, (2009), Introduction to Modern Virology, 6thEdition,Wiley-Blackwell.

MB1.2Hardcore: BACTERIOLOGY

CoursePedagogy:

- Tostudythescope,history,economicimportance,cellstructure,growth,cultivationandcontrolofbacteria.
- Workingprinciples ofmicroscopy and staining.

CourseOutcome:

Afterthe completion ofthe coursestudentswould beable:

- Toknowbacterialclassification,nutrition,cultivation,preservationofmicrobialculture.
- Todescribethemorphologicalfeatures,cellarrangementandstructuralcomponentsofbacterialcell.
- To enlist thecharacteristicsof Achaea.
- Tousedifferentmicroscopes forstudying bacterialmorphology.
- Toworkinmedicallaboratories,pharmacological,foodandfermentation industries.

THEORY48hours

UNITI **12 hours**

Introduction: Important events in development of bacteriology, Scope and relevance of bacteriology.Economicimportanceof bacteria.

Cell Structure: An overview of bacterial size, shape and arrangement, structure, chemical compositionof cell wall of Archaebacteria, gram-negative bacteria, gram-positive bacteria and acid fast bacteria, cellwalldeficientorganismsincludingL-formstructure,compositionandfunctionofcellmembrane,capsule, flagella, pili, Inclusion bodies, ribosomes, mesosomes, reserve food materials , magnetosomesand phycobilisomes, endospores, bacterial nucleic acids – chromosome, plasmid, transposons, integronsandantibiotic resistancecassettes.

Microscopy: WorkingPrinciplesofbrightfieldmicroscope,fluorescentmicroscope,darkfieldmicroscope,phasecontrastmicroscope,stereomicroscope,confocalmicroscopyandelectronmicroscope.Preparationof sample forelectronmicroscopicstudies.Applicationandimportance ofabovemicroscopes.Measurement ofmicroscopicobjects.

UNIT II **12 hours**

Bacterialclassificationandtaxonomy: Criteriafortheclassificationofbacteria.Phenetic,Phylogenetic, Genotypic, Numerical taxonomy. Techniques for determining microbial taxonomy andPhylogeny.ICNB rules. Classification systems of major categories and groups of bacteria according toBergey are manual of Systematic Bacteriology and Determinative Bacteriology. Non-culturable methodsforthe identification ofpathogenicmicroorganisms.

UNIT III **12 hours**

Growth, Cultivation and control of Bacteria: Nutrient requirements, nutritional types of bacteria,culture media, classification of media. Growth: Nutritional uptake, Growth kinetics, generation time,growthcurve,factorsaffectinggrowth.Methodsformeasurementofmicrobialgrowth–directmicroscopy, viable countestimates,turbidometry, and biomass.Aerobic, anaerobic, batch, continuousand synchronous cultures.Methods of pure culture isolation, Enrichment culturing techniques, single cellisolation, and pure culture development. Preservation and Maintenance of Microbial cultures: Repeatedsub culturing, preservation at low temperature, sterile soil preservation, mineral oil preservation, deepfreezingandliquidnitrogenpreservation,lyophilization.IUBS–InternationalUnionofBiologicalSciences.World federation for culturecollections– guidelines, statuetsand bylaws.

Controlofmicroorganisms: Antimicrobialagents,physicalandchemicalmethods.Principles,functioningand types ofBiosafety cabinets.

UNIT IV **12 hours**

CharacteristicsandSalientfeaturesofmajorgroupsofBacteria:Archaebacteria:generalcharacteristicsandclassification;extremophiles,halophiles,thermophilesandbarophiles;Generalcharacteristics,classification,diversityanddistribution,economicimportanceof**Actinomycetes,Cyanobacteria**.**Bioluminescentbacteria;**characteristicsandexamples,mechanism ofbioluminescence.Generalcharacteristics,lifecycle,growth,multiplicationandsignificanceof**Mycoplasma,Rickettsiae andChlamydia.**

References:

1. AlfredBrown(2011)Benson'sMicrobiologicalApplicationsShortVersion(Brown,MicrobioligicalApplications) ,12th edition, McGraw-Hill Science/Engineering/Math.
2. JacquelynG.Black(2012)Microbiology:PrinciplesandExplorations,8th edition,Wiley.
3. JeffreyC.Pommerville(2010)Alcamo's FundamentalsofMicrobiology,9thRevisededition,JonesandBartlettPublishers,Inc.
4. JeffreyC.Pommerville(2010)Alcamo'sLaboratoryFundamentalsofMicrobiology,JonesandBartlettPublishers,In c.
5. JeromeJ.Perry,JamesStaley,StephenLory(2002),MicrobialLife,SinauerAssociates.
6. Mara, Duncan, and Nigel J. Horan, (2003). Handbook of water and wastewater Microbiology, AcademicPress.
7. MichaelJ.Leboffe,Burton E.Pierce, DavidFerguson(2012)MicrobiologyLaboratoryTheory &Application,Brief, 2ndEdition, Morton Publishing Company
8. Michael T. Madigan, David P. Clark, David Stahl, John M. Martinko, 2012, Brock Biology ofMicroorganisms13th Edition, BenjaminCummings
9. Sherwood, and Woolverton Willey (2007), Prescott, Harley, and Klein's Microbiology (7th InternationalEdition),McGraw-Hill
10. StuartHogg(2013)EssentialMicrobiology,2ndEdition,Wiley-Blackwell

MB1.3Hardcore: MYCOLOGY

CoursePedagogy:

- Itincludes thestudy oftaxonomicclassification,fungi assymbionts.
- Fungiinproductionoffoodsupplementslike SCP,vitamins,enzymes,organicacidsandproduction ofsecondarymetabolites likeantibiotics.
- Inpracticalclassesthey mountthefungi,learnmicroscopicviewsandthe keycharacteristicstoidentifydifferentspecies offungi.

Courseoutcome:

Afterthe completion ofthe coursestudentswould beable

- Tounderstandthegeneralcharacteristicsandreproductioninfungiandlichens.
- Tounderstandthe economicandpathological importanceoffungi.
- Toidentifycommonfungalplantdiseasesanddevicecontrolmeasuresandworkasplantdoctor.

THEORY **48hours**

UNIT I **12 hours**

Introduction: History and Development of Mycology, scope of mycology. Recent developments inMycology.

Fungal taxonomy: Taxonomic problems associated with variation in fungi, Classification of fungi(Alexopoulosand Mims).

UNIT II **12 hours**

General characteristics of fungi and reproduction: Morphology and somatic structures: The thallus,organization, fungal cell, nuclear components, specialized somatic structures; Aggregation of hyphae,tissues, mycangia, General aspects of fungal nutrition and reproduction (Asexual, Sexual reproduction,Heterothalismand Parasexuality)

UNIT III **12 hours**

Salient features of fungal major groups: Chytridiomycota, Zygomycota,Basidiomycota, Ascomycota,Deuteromycota,Oomycota,Hypochytriomycota,Labyrinthulomycota,Plasmodiophoromycotaand Myxomycota.Symbioticfungi-Lichens.

Opportunisticfungalinfections:*Candidaalbicans,Aspergillusfumigatus*andMucormycosis.

UNIT IV **12 hours**

Economicimportanceoffungi: Fungiasbiocontrolagent,EconomicimportanceofFungiinAgriculture, Industry and medicine. Fungi as SCP, Fungi as parasites of human and plants.Role of fungiinbio-deteriorationofwoodandpaper.Mycorrhiza–
ectomycorrhiza,endomycorrhiza,vesiculararbuscularmycorrhiza.Fungi as insectsymbionts.

Important metabolites of Fungi – aflatoxin, Ochratoxin, Ergot alkaloids, T-2 toxin, DON, Fumonisin.Impact of mycotoxins on human health.Importance of secondary metabolites of fungi as nephrotoxins,neurotoxins,hapatotoxins,mutagens/carcinogens.

Reference:

1. AlexopoulasCJandMimsC W,1979IntroductoryMycology3rdedn,WileyEastern.,New Delhi.
2. David Moore, Geoffrey D. Robson, Anthony P. J. Trinci (2011) 21st Century Guidebook to Fungi.CambridgeUniversityPress.
3. Deacon,JW,1997-ModernMycology 3rdEdition,BlackwellSciencepublishers,London.
4. KevinKavanagh(2011) Fungi:Biology andApplications.JohnWiley& Sons,Sussex,U.K.
5. Mehrotra,RS&Aneja, KR,1998. AnIntroductiontoMycology.NewAgeInternationalPvt.Ltd.NewDelhi.
6. MercedesS.Foster&GeraldF.Bills(2011)BiodiversityofFungi:InventoryandMonitoringMethods.AcademicPress
7. MichaelJohnCarlile,SarahC.Watkinson,G.W.Gooday(2007)Thefungi.AcademicPress.London,U.K
8. Odum,E.P. 1971.Fundamentals of Ecology;Third Edition.Toppan Co. Ltd.Tokyo,Japan.

MB1.4Soft-core:MICROBIALGENETICS

CoursePedagogy:

- Describethefundamentalmolecularprinciple ofgenetics.
- Understandthe relationshipbetween phenotypeandgenotype.
- Describethebasics ofgeneticmapping.
- Understandhowgeneexpressionisregulated

CourseOutcome:

Afterthe completion ofthe coursestudentswould beable

- ToUnderstandtheGenetic constituentsofbacteriawithspecialemphasisoninheritance.
- Toextend theknowledgeonmolecularbasis ofmutation atmicrobiallevel.
- Tofocus ongeneregulationand expressionmechanisms.
- Tounderstandtheprinciplesroleofplasmidsandgenetransfermethodsandmapping.

THEORY **48hours**

UNITI **12 hours**

ConceptsinMicrobialGenetics: HistoryanddevelopmentsofMicrobialgenetics.Essentialsofmicrobial genetics: Microbes as Genetic Tools for Basic and Applied Genetic studies. Advantages anddisadvantages of Microbes, Generalized reproductive cycles of microbes- *Neurospora*, *Saccharomyces,Chlamydomonas*and*Acetabularia.*

UNIT II **12 hours**

Viral Genetics: Lytic and Lysogenic cycles, Phage Phenotypes, Phenotypic Mixing, Recombination inviruses:Mutations, Recombination and Mapping (rIIloci)

BacterialGenetics: BacterialTransformation:Typesoftransformationmechanismsfoundinprokaryotes, Bacterial Conjugation: properties of the F plasmid, F+ x F - mating, F' x F- conjugation, Hfrconjugation,genemappinginbacteria. Transduction:Generalizedandspecializedtransduction,Transposable elements.Regulation of competence in *Bacillus.*

UNIT III **12 hours**

Fungal Genetics: *Neurospora*- Tetrad analysis and linkage detection - 2 point and 3 point crosses,chromatidand chiasmainterference, Mitoticrecombinationin*Neurospora*and*Aspergillus*.

AlgalGenetics:*Chlamydomonas*– unorderedtetradanalysis-RecombinationandMapping,Nucleocytoplasmicinteractionsandgeneexpressionin*Acetabularia*.Extranuclear(Cytoplasmic)inheritance.

UNIT IV **12 hours**

Mutation and mutagenesis: Nature, type and effects of mutations. Concept of gene: muton, recon and cistron. Mutagenesis – physical and chemicalmutagens,baseandnucleosideanalog,alkylatingagents,interrelatingagents,ionizingradiation.Induction anddetectionofmutationinmicroorganisms.Sitedirectedmutagenesisand itsapplications.

References:

1. D.PeterSnustad,MichaelJ. Simmons(2011)PrinciplesofGenetics, 6thEdition;Wiley
2. Dr.EvelynJ.Biluk(2012)MicrobiologyStudyGuide:MicrobialGenetics, ControllingMicrobialGrowth,and AntimicrobialAgents; CreateSpaceIndependentPublishingPlatform
3. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick(2013)Molecular Biology ofthe Gene,7thedition; BenjaminCummings
4. JocelynE.Krebs,ElliottS.Goldstein, StephenT.Kilpatrick(2012)Lewin'sGENES XI,11thedition;Jones& BartlettLearning
5. JohnR.S. Fincham(1996)Microbial andMolecularGenetics; HodderArnold
6. LarrySnyder,JosephE.Peters,TinaM.Henkin, WendyChampness(2013)MolecularGeneticsofBacteria,4th Edition; ASMPress
7. NancyJoTrun,J.E.Trempy(2003)Fundamental BacterialGenetics;Wiley-Blackwell
8. RoystonC.Clowes,WilliamHayes(1968)ExperimentsinMicrobialGenetics;BlackwellScienceLtd
9. SriramSridhar(2005)GeneticsandMicrobialBiotechnology;DominantPublishers&Distributors
10. Stanley R. Maloy, Jhon E. Cronan, Jr. David Freifelder (1994) Microbial Genetics (Jones and BartlettSeriesin Biology),2nd edition; Jones and BartlettPublishers
11. UldisN.Streips,Ronald E.Yasbin(2002)ModernMicrobialGenetics,2nd edition;Wiley-Liss
12. VenetiaA.Saunders(1987)Microbialgenetics appliedtobiotechnology:principlesandtechniquesofgenetransferand manipulation;Springer

MB1.5Soft-core:MICROBIALECOLOGYANDDIVERSITY

CoursePedagogy:

- Tounderstandtheubiquitous natureofmicrobes.
- Togivebasicknowledge onextremophiles.
- Toprovideknowledgeoncharacteristics ofMicrobes.

CourseOutcome:

Afterthe completion ofthe coursestudentswould beable

- Studentsabletodifferentiatevarious groupsofMicrobes.
- Getknowledgeonadaptabilityofextremophiles.
- Knowledgeabout microbialtaxonomy.

THEORY **48hours**

UNITI **12 hours**

Introduction to microbial ecology: Structure of microbial communities. Interaction among microbialpopulations.Interactionbetweenmicroorganismsandplants.Biotransformation,biodegradation,bioremediationandphytoremediation.EcologicalandEvolutionarydiversity(Geneticdiversity)ofmicrobialworld

Development of Microbial communities: Dynamics of community, ecological succession, structure,dispersion,microbial communities in natureand ecosystem models

UNIT II **12 hours**

Physiological Ecology of microorganisms: Adaptation to environmental conditions **-** abiotic limitationstomicrobial growth.

Viral Diversity: Group I – T2 Bacteriophage, Group II – Banana bunchy top virus, Group III – Reovirus,GroupIV-TMV,GroupV –Rhabdovirus, GroupVI– HIV,GroupVII–Hepatitisvirus.

Sub-viralparticles:Discovery,Structure,Classification,replicationanddiseasescausedbySatellite,Satellitesvirus, Virusoids, Viroids and Prions.

UNIT III **12 hours**

BacterialDiversity: Archaebacteria,PhotosyntheticEubacteria,ChemoautotrophicandMethophilicEubacteria, Gliding Eubacteria, Spirochetes, Rickettsiae and Chlamydiae, Actinomycetes, Mollicutes,Protists

FungalDiversity:salientfeaturesofthefollowinggroup:Zygomycota(*Rhizopus*),Ascomycota*Neurospora*),Basidiomycota(*Agaricus*),Deuteromycota(*Penicillium*),Chytridiomycota(*Allomyces*)Myxomycotaand Yeast.

UNIT IV **12 hours**

ImportanceandConservationofMicrobialDiversity:Importanceofmicrobialdiversityinenvironment,pharmaceuticals&humanhealth.Metagenomics.Importanceofconservation.*Insitu*conservationand *Exsitu*conservation.Role ofculturecollectioncenters inconservation.

References

1. Atlas, Ronald M., Bartha, Richard (1997) Microbial Ecology Fundamentals and Applications; Addison-Wesley
2. Colwell,R.R., Simidu,Usio, Ohwada,Kouicki (1996)Microbial Diversityin TimeandSpace;Springer
3. DavidL.Kirchman (2008)MicrobialEcologyoftheOceans;Wiley-Liss
4. DavidL.Kirchman (2012)ProcessesinMicrobial Ecology;OxfordUniversityPress
5. JamesW.Brown(2014)PrinciplesofMicrobial Diversity;ASMPress
6. McArthur,J.Vaun(2006)MicrobialEcologyAn EvolutionaryApproach; AcademicPress
7. Nelson,KarenE.(1997) AdvancesinMicrobialEcology;Springer
8. OladeleOgunseitan(2004)MicrobialDiversity:FormandFunctioninProkaryotes;Wiley-Blackwell
9. OladeleOgunseitan(2008)MicrobialDiversity:FormandFunctioninProkaryotes;Wiley-Blackwell
10. Osborn,A.M.,Smith,Cindy(2005)MolecularMicrobialEcology;Taylor &FrancisGroup
11. PierreDavet(2004)MicrobialEcology oftheSoilandPlant Growth;SciencePubInc
12. RonaldM.Atlas,RichardBartha(1997)MicrobialEcology:FundamentalsandApplications(4thEdition);Benjamin Cummings
13. Satyanarayana,T.,Johri,B.N.(2005)MicrobialDiversity:CurrentPerspectivesandPotentialApplications;I.K.International Publishing HousePvt.,Limited

MB1.6Softcore:PracticalI(VirologyandBacteriology)

1. Laboratorysafetyrules
2. Microscopicmeasurementofmicroorganismsbymicrometry
3. Culturingandmaintenanceofbacterialcultures
4. Isolationand enumerationofbacteriafromsoil
5. Isolationand enumerationofbacteriafromwater
6. Culturalcharacteristicsofbacteria
7. Stainingtechniques–simple(positiveandnegative),differential(Gramsandacidfast),structural(endosporeand capsule)
8. Motilitytest(hanging dropmethodand softagarmethod)
9. Biochemicaltestsforthe identification ofbacteria–catalase,oxidase, IMViC,Urease,TSIA, Nitrate reduction, gelatin, starch, casein,esculinhydrolysis and Litmus Milk test.
10. Determinationofgrowth curvein *E.coli*.
11. DiauxicgrowthcurveinE.coli
12. Isolationofcoliphagesfromsewage
13. Studyofmorphological changesduetoviralinfection inplants

MB1.7Softcore:PracticalII(MycologyandMicrobialGenetics)

1. Isolationofslimemolds.
2. Isolationofaquaticfungi.
3. Isolationofsoilfungi.
4. Isolationoffungifromair.
5. Isolationoffungifromcerealsandcerealbasedproducts.
6. Studyofthefollowingrepresentativegenera:*Aspergillus,Penicillium,Fusarium,Neurospora,Saccharomyces, Erysiphae,Polyporus,Agaricus,Puccinia,Ustilago,Alternaria,Drechslera,Saprolegnia,Rhizopus, Trichoderma*and symbiotic fungi-Lichens.
7. MeasurementofconcentrationoffungalconidiabyHaemocytometer.
8. Measurementoffungalcellsby Micrometer.
9. Replicaplatingtechnique fortransferofbacterialcolonies.
10. Ultra-violetkillingcurveanddeterminationofmutanttypesin *Saccharomycescerevisiae.*
11. Inductionofmutation
12. Isolationofstreptomycin resistantstrainof*E.coli*by gradientplatemethod.
13. Study of Conjugation in *E.coli*
14. IsolationofgenomicDNAfrom bacteriabyheat lysismethod.
15. Isolationof genomicDNA fromyeast by DNAspooningmethod.
16. ExtractionofmycotoxinsanddetectionbyTLC.

SEMESTERII

MB2.1Hardcore: MICROBIALPHYSIOLOGY

CoursePedagogy:

- Todevelopunderstandingaboutmicrobialmetabolism,growthandenergygeneration.
- Gainknowledgeofvariousfermentationpathways,microbialcommunicationandenergetics.
- Toacquireknowledgeonmicrobialstressresponse.

CourseOutcomes:

Afterthe completion ofthe coursestudentswould beable.

- Toacquaintwithbasicsofmetabolism andgrowthundernormalandstressedconditions.
- To understand major fermentation, aerobic and anaerobic pathways for energy generation in microbialcells.
- Toknowtheconceptsofmicrobialcross-talk.

THEORY **48hours**

UNITI **12hours**

Microbialbioenergetics:TheroleofATPinmetabolism.Microbialenzymesandmechanismof Enzymeaction and kinetics.Inhibition andregulation– allosteric,feedback,competitive,non-competitive.

Metabolism of Carbohydrate: Glycolysis, Citric acid Cycle and different types of Phosphorylation,Fates of pyruvate, Fermentation. Utilization of sugars other than glucose: Lactose, Galactose, Maltose,Mannitol.Degradation ofcellulose, Starch andGlycogen.

UNITII **12 hours**

Lipidmetabolism:β-oxidation,Biosynthesisoffattyacids,degradationoffattyacids.

Nitrogen metabolism: Nitrogen metabolism, Biological nitrogen fixation process, symbiotic and non-symbiotic nitrogen fixation. Degradation and biosynthesis of essential and non-essential amino acids.**Nucleicacidmetabolism**: Biosynthesis anddegradation ofpurines andpyrimidines.

UNIT III **12 hours**

MicrobialPhotosynthesis: PhotosyntheticPigmentsandapparatusinbacteria.OxygenicandAnoxygenic.Photosynthesis.Autotropic CO_2 fixation and mechanism of Photosythesis.Utilization oflightenergy by Halobacteria.

Autotrophic Mechanisms in bacteria: Hydrogen bacteria, Nitrifying bacteria, Purple sulphur bacteria,Non-sulfurbacteria,Green sulfurbacteria,Ironbacteria, Methylotrophs.

UNIT IV **12 hours**

MicrobialSignalingandStressresponse:TwoComponentsignaltransductioninprokaryotes:Chemotaxis, Quorum sensing, biofilms, response to anti microbials, sporulation inducing signals andeventsinsporulation;Dormancy,osmolarityporinregulationin*E.coli*(*Omp*system),phosphateassimilationin*E. coli*(Phosystems),Nitrogenfixationin*Klebsiella*and*Rhizobium*(Ntrsystem).Oxidativestress, Thermal stress, Starvation stress,Aerobicto anaerobictransitions.

References:

1. AlbertG.Moat,MichaelP.Spector JohnW.Foster(2009)Microbial Physiology;BWSTM
2. ByungHongKim,GeoffreyMichaelGadd(2008) BacterialPhysiologyandMetabolism;CambridgeUniversityPress
3. DanielR.Caldwell(1999) MicrobialPhysiology andmetabolism; StarPubCo
4. DavidWhite,James Drummond,Clay Fuqua(2011)ThePhysiologyandBiochemistry ofProkaryotes,OxfordUniversityPress
5. Frederick C. Neidhardt, John L. Ingraham , MoselioSchaechter (1990)Physiology of the Bacterial Cell:AMolecularApproach; Sinauer AssociatesInc
6. RobertK. Poole (2014)Advances in Microbial Systems Biology, Volume64 (Advances inMicrobialPhysiology);AcademicPress
7. Rose,AnthonyH.()Advances inMicrobialPhysiology,Vol. 9;ElsevierScience&TechnologyBook
8. Rose,AnthonyH.(1976) ChemicalMicrobiologyAn IntroductiontoMicrobialPhysiology;BasicBooks

MB 2.2 HARDCORE: IMMUNOLOGY

CoursePedagogy:

- Toprovideoverviewofimmunesystem,antigen,antibody structureandinteractions.
- Understandingofinnate andadaptiveimmunityalongwithmajorcellsandmoleculesinvolved.
- To integrate immunology with health and enrich the knowledge for autoimmune disorders,hypersensitivity reaction.

CourseOutcomes:

Afterthe completion ofthe coursestudentswould beable

- Togainknowledgeofimmune system,cells involvedalong withcomplement systemandautoimmunity.
- Toevaluatetheusefulnessofimmunologyindifferentpharmaceuticalcompanies
- Tounderstandimmunesystem,antigenantibodyinteractions.
- Togaintheoreticalknowledgeofvariousdiseasedconditionsgeneratedduetointerplayofimmunesystem components

THEORY 48hours

UNIT I **12 hours**

Introduction to Immunology: An overview of immune system, Phagocytes, Natural killer cells, mastcells, basophils, Dendritic cells and other cells of the inmate immune system. Immunity: Types- Innateimmunity: (nonspecific) physical, biochemical and genetic factors involved in governing innateimmunity, molecules of inmate immunity – complement, acute phase proteins and interferons;Chemokines and Cytokines . Acquired immunity: (specific) natural, artificial, passive immunity, humoral or antibody mediated immunity, cell mediated immunity.

UNIT II **12 hours**

Antigens and Antibodies:

Antigens: Properties of antigen, Super antigen, Hapten. `**Major Histo-compatibility Complex (MHC) and Antigen presentation:** Types, Structure and functions of MHC molecules, Presentation of Bacterial and Viral Antigens: Phagocytosis, Processing and presentation of antigens by Class I and class II MHC molecules.

Antibodies (Immunoglobulins) – Structure and function.Ig gene organization and generation of Ab diversity.Monoclonal antibodies production and its clinical applications; Antibody engineering. **Hypersensititivity**: Hypersensitivity reactions, Types and their roles in Immunopathological processes. Autoimmune processes: Immunologic tolerance, genetic predisposition to the development of autoimmune processes. Autoimmune disorders- Immunopathogenesis of sclerosis multiplex, psoriasis vulgaris, Rheumatoid arthritis), Immunodeficiency diseases

UNIT III **12 hours**

Transplantation of tissues and organs: Nomenclature of transplantations. Recognition of self and non-self-Transplantation reactions, HvG and GvH. Exception from rejections. HLA Typing: Antibody dependent cell mediated cytotoxicity, mixed lymphocyte reactions. Kidney and bone marrow transplantations.

Immuno stimulatory and immune suppressive drugs and their mechanism.

Antigens and Antibody reactions: Agglutination, complement fixation test, ELISA, immunodiffusion, immunoelectrophoresis, immunoflourescence,immunoprecipitation, radioimmunoassay, Western blotting, flow-cytometry and immunohistochemistry.

UNIT IV **12 hours**

Immune response to infectious diseases and Vaccines:

Viral Diseases: Neutralization of Viruses, Cell mediated immunity to control viral pathogens, Viruses can evade defense mechanisms. **Bacterial Diseases:** Immune response to extracellular and intracellular bacteria, bacteria can evade defense mechanisms, Immune response to Bacterial pathogenesis. **Parasitic Diseases:** Immune response to Malaria, Trypanosoma, Leishmaniasis. **Fungal Diseases:** Innate and Acquired Immunity to control fungal infections.

Vaccines – Definition,active and passive immunization, designing vaccines for active immunization. Live attenuated vaccines, Inactivated or killed vaccines, Subunit vaccines (Toxoids, Bacterial polysaccharide capsules, viral glycoproteins, Recombinant vaccines, multivalent subunit vaccines), DNA vaccines. Effectiveness ofvaccines, Vaccine safety, current vaccines andNational vaccination schedule**.**

References:b

1. AbulK.Abbas(2014)CellularandMolecular Immunology ;Saunders
2. AbulK.Abbas,Andrew H.H.Lichtman,ShivPillai(2011)CellularandMolecularImmunology;Saunders
3. AbulK.Abbas,Andrew H.H.Lichtman,ShivPillai(2012)Basic Immunology:FunctionsandDisordersofthe ImmuneSystem,;Saunders
4. Delves,PeterJ.,Martin,SeamusJ.,Burton,DennisR.(2011)Roitt'sEssentialImmunology;Wiley&Sons,Incorporated, John.
5. GeorgePinchuk(2001)Schaum'sOutlineof Immunology;McGraw-Hill
6. HelenChapel,ManselHaeney,SirajMisbah,NeilSnowden(2014)EssentialofClinicalImmunology;Wiley-Blackwell
7. JudyOwen,JenniPunt,SharonStranford(2013) KubyImmunology;W.H.Freeman
8. LouiseHawley,Benjamin Clarke,RichardJ.Ziegler(2013)Microbiologyand Immunology;LWW
9. PeterParham(2009)The ImmuneSystem,3rdEdition;GarlandScience
10. WilliamE.Paul(2012)Fundamental Immunology;LWW

MB2.3:Soft-core:FOODMICROBIOLOGY

CoursePedagogy:

- Thecourseaimsto provideinstructionin thegeneralprinciples offoodmicrobiology.
- Thecoursecoversthebiologyandepidemiologyoffoodbornemicroorganismsofpublichealthsignificance,including bacteria, yeasts, fungi, protozoaandviruses.
- Understand food spoilage microorganisms; the microbiology of food preservation and food commodities;fermented and microbial foods; principles and methods for the microbiological examination of foods;microbiological quality control, andquality schemes.
- To supplement the academic input of students by way of seminars, conferences, guest lectures and industry oriented projects/visits.

CourseOutcome:

Afterthe completion ofthe coursestudentswould beable

- Tounderstandtheprinciplesofmicroorganismsduringvariousfood-processingandpreservationsteps.
- Tocomprehendtheinteractionsbetweenmicroorganismsandthefoodenvironment,andfactorsinfluencingtheir growthand survival.
- Tounderstandthesignificanceand activitiesofmicroorganismsinfood.
- To recognize the characteristics of food-borne and spoilage microorganisms, and methods for theirisolation,detection andidentification.
- Toanalyzetheimportanceofmicrobiologicalqualitycontrolprogramme's in foodproduction.
- To describe the rationale for the use of standard methods and procedures for the microbiological analysisoffood.

THEORY **48hours**

UNITI **12hours**

Introduction to food microbiology: Definition, concepts and scope. Food as substrate for microbes.Factorsinfluencingmicrobialgrowthinfood – Extrinsicandintrinsicfactors.Principlesoffoodpreservation-ChemicalpreservativesandFoodadditives.Asepsis-Removalofmicroorganisms,(anaerobicconditions,hightemperatures,lowtemperatures,drying).Canning,processingforHeattreatment.

UNIT II **12 hours**

Contamination and food spoilage: Cereals, sugar products, vegetables, fruits, meat and meat products,Fishand seafoods-poultry-spoilageofcannedfoods.

DairyMicrobiology: Microbiologyofrawmilk,Milkasavehicleofpathogens,Preventionofcontamination of raw milk, Microbiology of processed milk, Spoilage and defects fermented milk andmilk products, Microbiological standards for milk and milk products. Cream and butter bacteriology.Prebioticsand Probiotics.

UNIT III **12 hours**

Food poisoning and intoxication: Significance of food borne diseases, Food poisoning and intoxication:Botulism,Listeriosis,*Bacilluscereus*foodpoisoning,FoodborneGastroenteritisby*Salmonella,Shigella, Vibrio, Campylobacter* and *Yersinia*, Staphylococcus and Staphylococcal enterotoxins, fungalspoilage and Mycotoxins. **Introduction to biowarfare**: Food and water as media to transmit food bornethreatto health; policiesandpractices.

Microbes as alternate food – single cell proteins, sea weed (algae), mushroom cultivation.Bioconversions-productionofalcohol-fermentedbeverages – beerandwine.Geneticallymodifiedfoods.

UNITIV **12 hours**

Detection of food-borne microorganisms: Culture, Microscopic and Sampling methods. Chemical:Thermostable nuclease *Limulus* Lysate for Endotoxins, Nucleic Acid (DNA) probes, DNA Amplification(PCR),Adenosine-TriphosphateMeasurement,Radiometry,Fluoro-andChromogenicsubstrates.ImmunologicMethods:FluorescentAntibody,EnrichmentSerology,Salmonella1-2.Test,Radioimmunoassay,ELISA.

Microbialindicatorsoffoodsafetyandqualitycontrol: Principlesofqualitycontrolandmicrobiologicalcriteria,Indicatorsofproductqualityandmicrobiologicalsafetyoffoods,Hazardanalysis,criticalcontrolpoints(HACCP),Goodmanufacturingprocess(GMP)MicrobiologicalstandardsCodexAlimentarius andFood legislationwithrespect toFSSAI,NABLandISO

References:

1. AdamsM.R.andMoss M.O.2007.Food Microbiology3rdEdition.Royal SocietyofChemistry.UK.
2. AhmedE.Y.andCarlstromC.2003FoodMicrobiology: ALaboratoryManual,JohnWileyandSons,Inc.New Jeresy.
3. BibekRay,ArunBhunia.2013.FundamentalFoodMicrobiology,FifthEdition.CRCPress
4. CBlackburn.2006.FoodSpoilageMicroorganisms.WoodheadPublishing.
5. DongyouLiu.2009.MolecularDetection of FoodbornePathogens.CRC Press.
6. ElmerH.Marth,James Steele.2001.Applied DairyMicrobiology,SecondEdition. CRCPress.
7. Frazier W.C. and Westhoff C.D. 2008 Food Microbiology. Tata McGraw Hill Publishing CompanyLimited,New Delhi.IndianEdition.
8. Jay,JamesM., Loessner, MartinJ., Golden,David A.2004.ModernFoodMicrobiology.7thed. Springer
9. Marshall,RichardJ.(Ed.).2007.FoodSafety. Springer.
10. Pina M. Fratamico, Arun K. Bhunia, and James L. Smith. 2008. Foodborne Pathogens: Microbiology andMolecularBiology. CaisterAcademicPress.
11. Pitt,JohnI.,Hocking,Ailsa D.2009.Fungiand Food Spoilage3rdEdition.Springer.
12. Sperber, William H., Doyle, Michael P. (Eds.). 2010. Compendium of the Microbiological Spoilage ofFoodsand Beverages. Springer.
13. StephenJ.Forsythe.2010.TheMicrobiologyofSafeFood,2ndEdition.Wiley-Blackwell.

MB2.4:Softcore:SOILMICROBIOLOGY

CoursePedagogy:

- Lecturesareheldwith thehelpof slides,thelaboratory lessonswillbeperformed inalaboratorydesignedand equippedfor microbiological practices.
- The laboratory practices will be performed in groups of students. The e-learning site will be used toprovideteaching materialand to communicate with thestudents.
- Theinteractionbetweenteacherandstudentstake placethroughtutorials,seminarsandIntermediatewrittentests.

CourseOutcome:

Afterthe completion ofthe coursestudentswould beable

- Tohaveknowledgeaboutsoilas anexcellenthabitat formultitudeof microorganismsbalancingthesoilecosystem.
- Tobeemployableinthe fieldofAgronomy/SoilScience
- Toacquireskillsand knowledge on theimportanceofmicroorganismsinbiogeochemicalcyclesbiologicalfertility ofsoil.

THEORY **48hours**

UNIT I **12hours**

Soil Microbiology: Historical accounts and the "Golden Age" of soilmicrobiology and significantcontributionsof pioneersoil microbiologists.

SoilMicrobialdiversity:Soilashabitatformicrobes;soilpH,temperatureandsoilatmosphere.Diversity and abundance of dominant soil microorganisms, Methods of isolation of soil microflora, soilorganicmatter decomposition,

UNIT II **12 hours**

Biogeochemical cycles: Organic matter decomposition, humification. Carbon, sulphur, nitrogen and ironcyclesin soil.

Soil microbe interaction - Antagonism, commensalism, mutualism, symbiosis, predators and parasiterelationship and competition.Interaction of soil microflora with vascular plants - Rhizosphere, rhizoplanemicroorganisms, *Rhizobium*, *Azatobacter*, *Azospirillum*, *Cyanobacteria*and*Azolla*.

UNIT III **12 hours**

Techniques to study soil organisms: Microbial biomass estimation**;** fumigation-incubation technique,fumigation-extraction method, substrate-induced respiration method and Using ATP or enzyme activity.

Applied soil microbiology: soil microbial inoculants, Manipulations of soil microorganisms foragriculture, Soil environmental contaminants and Bioremediation, Microbial products- Plant growthpromotingHormones, Antibiotics, Toxins and Enzymes

UNITIV **12 hours**

Soil-Borne Diseases and Human Health: *Clostridium tetani*(tetanus), Toxoplasmosis, Aspergillosis,Actinomycosis.

Soil microorganisms in agro ecosystems: Types of microbial communities; soil microbial diversity:significance and conservation; effect of agricultural practices on soil organisms. Biological nitrogen-

fixation:Therangeofnitrogenfixingorganisms;mechanismofnitrogenfixation(biochemistryofnitrogenase);

genetics of nitrogen-fixation; *Rhizobium*-Legume Association; Sym plasmids, N2 fixationbynon-leguminous plants.

References:

1. Agrios,G.N. 2000.Plant pathology.HarcourtAsiaPvt.Ltd.
2. Bergersen, F.J.andPostgate,J.R.1987.ACentury ofNitrogenFixationResearchPresentStatusandFutureProspects. The RoyalSoc.,London.
3. Buchanan,B.B.,Gruissem,W.andJones,R.L.2000.BiochemistryandMolecularBiologyofPlants.
4. Burges,H.D.1981.Microbialcontrolofinsectpests,Mitesandplantdiseases.Academic,London.
5. Dixon, R.O.D. and Wheeler, C.T. 1986. Nitrogen Fixation in plants. Blackie USA, Chapman and Hall,NewYork.
   I.K.InternationalPvt.Ltd.
6. Kannaiyan,S.1999.BioresourcesTechnologyfor sustainableagriculture.Assoc.Pub.Co.NewDelhi.
7. Mehrotra,R.S.2000.Plantpathology.TataMcGraw – HillPublishingCompanyLimited.
9. Metcalf,R.L.andLuckmann,W.H.1994. Introductiontoinsectpestmanagement 3 edn.JohnWilleyandSons,Inc.
10. Motsara, I.M.R.,Bhattacharyya,P.andSrivastava,B.1995.BiofertilizerTechnology,Marketingandusage-AsourceBook-cum-glossary-FDCO, NewDelhi.
11. Somasegaran,PandH.J.Hoben,1994.HandbookforRhizobia;methodsinlegume*Rhizobium* Technology.Springer-Verlan,NewYork.

MB2.5Softcore:PRACTICALIII(MicrobialPhysiologyandImmunology)

1. Populationgrowthofyeast –*S.cerevisiae*.
2. Populationgrowthofbacteria –*E.coli*.
3. Sugarfermentationtests.
4. Catalaseactivity.
5. Hydrolyticrancidity.
6. Caseinhydrolysis.
7. Carbohydratecatabolism bymicrobes
8. StudyofacidandpHstresstolerancebymicrobes.
9. Effect of temperature on microbial growth
10. Effectofmolecularoxygenonmicrobialgrowth.
11. Effectof osmotic pressureonmicrobialgrowth.
12. Effectofrelativehumidityonmicrobialgrowth.
13. Effectofdifferentwavelengthsoflightonmicrobialgrowth.
14. Precipitintest,ELISA,OuchterlonyImmunodifusiontest,and Radial Immunodiffusion
15. Determination of Blood grouping and rh factor
16. WIDALTest.
17. VDRLTest (RPR).
18. HBsAgTest.
19. HCGtest (Agglutinationinhibition test).
20. DetectionofRAfactor.
21. CRPtest.
22. ASOTest(Antistreptolysin‘O’Test).

MB2.6Softcore: PRACTICALIV(FOOD MICROBIOLOGY)

1. Detection and enumeration of Microorganisms present in Utensils.
2. Isolation and identification of pathogenic microorganisms from canned food.
3. Enumeration of bacteria in raw and pasteurized milk by SPC method.
4. Determination of quality of a milk sample by Dye reduction test (MBRT, Rezasurin).
5. Detection of number of bacteria in milk by breed-count method
6. Microbial quality of milk and milk products.
7. Microbiological examination of Fermented products
8. Evaluation of antimicrobial activity of food preservatives
9. Isolation and identification of common food borne pathogens (Enterobacteriaceae – *E.coli*, *Enterobacteraerogenes*, *Salmonella*, *Shigella*, *Staphylococcus*, *Listeria*, *Vibrio*, *Aspergillus*, *Penicillium*, and *Fusarium*)
10. Bacterialexaminationof drinkingwaterbymembranefilterstechnique.
11. DeterminationofTDT.
12. DeterminationofTDP.
13. Detectionandquantificationof AflatoxinB1.

MB2.7:OPEN ELECTIVE: MICROBIAL TECHNOLOGY

Course Pedagogy:

- The course will impart a comprehensive knowledge and understanding of techniques used in Microbiology, like microscopy, staining technique, culture media, sterilization methods and control of microorganisms.

Course Outcome:

After the completion of the course students would be able

- To acquire knowledge of culturing methods and identification of microorganisms.
- To enable them to isolate pure culture and preserve them and control measures.

THEORY **48 hours**

UNIT I **12 hours**

Microscopy: Light microscopy- Simple microscopy (dissection microscope), Compound microscopy (Bright field, Dark field, phase contrast, and Fluorescence microscopy) and stereomicroscopy. Electron-microscopy: Principles, construction and mode of operation of scanning and Transmission electron microscopy and limitations. Preparation of specimens for electron microscopic studies (Ultra-thin sectioning, negative staining, shadow casting and freeze etching). Confocal/ Laser scanning, programmable array microscopes

UNIT II **12 hours**

Microbiological stains and staining techniques: Types of stains and principles of staining. Stains for bacteria, fungi, algae, protozoa and spirochetes.Stains for Azotobacter cysts, stains for mycoplasma. Preparation of bacterial smears for light microscopy: Fixation, simple staining, Differential staining, Structural staining (Capsule, Flagella, Cellwall and Endospore of bacteria), and nuclear staining.

UNIT III **12 hours**

Culture media for Microbes Types of media- general purpose media, special purpose media, selective, elective, diagnostic, resustication media, Media for fungi, algae, bacteria, mycoplasma and viruses.

Sterilization techniques: Principles, types of Sterilization, and their mode of action. Physical methods: Heat-dry heat (Hot-Air oven), Incineration, Moist heat (Autoclave and Pressure cooker), Tyndalization (Fractional Sterilization), Filtration-Types of filters, Laminar airflow. Radiation methods (UV radiation, x-rays and cathoderays). Biosafety cabinets – Level I – IV, Containment labs – containment, high containment and maximum containment labs

UNIT IV **12 hours**

Control of Microorganisms: Chemical methods: Definition of terms- Disinfectants, Antiseptics, Sanitizers, Microbicides (bactericide, fungicide and Sporicide), Microbistatic (bacteristatic and fungistatic agents). Use and mode of action of Alcohols, Aldehydes, Halogens, Phenols, Heavy metals, and Detergents.

Pure culture techniques: Different types of inoculation techniques - Spread plate, Pour plate and Streak plate method

References:

1. Alcomo, I.E. 2001. Fundamentals of Microbiology. VI Edition, Jones and Bartlett Publishers, Sudbury, Massachusetts.
2. Aneja, K.R. 1993. Experiments in Microbiology, Plant Pathology. Rastogi and Company, Meerut.
3. Cappuccino, J. G. and Sherman, N. 1999. MICROBIOLOGY A Laboratory Manual 4thEdn. Addison – Wesley.
4. Becker, W.M., Kleinsmith, L.J. and Hardin, J.2000. The world of the Cell. IVth Edition. Benjamin/Cummings.
5. Kango.N.2010. Textbook of Microbiology. I.K. International Publishing House. New Delhi.
6. MadiganM.T.,Martinko M.J. and Parker,J. 2003. Brock Biology of microorganisms. Pearson education., New Jercy.
7. Pelczar, (Jr.) M.J., Chan, E.C.S. and Kreig,N.R.1993. Microbiology. McGraw Hill, New York
6. Perry, J.J. and Staley, J.T. 1997. Microbiology. Dynamics and Diversity. 4thedn. Wesley Longman pub. New York.
7. Perry,J.J., Staley,J.T. and Lory,S.2002. Microbial Life. Sinauer Associates, Publishers, Sunderland, Massachusetts.
8. Presscott, L.M. Harley, J.P. and Klein, D. A.1999.Microbiology, International edn.4thedn. WCB McGraw-Hill.
9. Schaechter, M. Ingraham,J.L. and Neidhardt,F.C.2006. Microbe. ASM Press, Washington. D.C.
10. Stainer, R. Y., Ingraha, J L, Wheelis, M. L. and Painter, P. K. 1986. General Microbiology. McMillanEdun. Ltd. London.
11. Stanley J.T. and Reysenbach A.L.1977. Biodiversity of microbial life. John Wiley 7 Sons Inc. Publication. New York.
12. Sullia, S.B. and Shantharam, S. 2000. General Microbiology (Revised) Oxford & IBH Publishing Co. Pvt. Ltd.
13. Talaro, K and Talaro, A.1996. Foundations in Microbiology, II edition, WCB publishers.
14. Tortora, G.J., Funke, B.R. and Case, C.L. 2004. Microbiology-An Introduction. Benjamin Cummings. San Francisco.

SEMESTER III
MB 3.1Hard-core: MOLECULAR BIOLOGY

Course Pedagogy:

- To extend the knowledge on structure and functions of genetic material
- To focus on genome organization, transcription and translation process in Prokaryotes.
- To understand the principles of oncogenes

Course Outcome:

After the completion of the course students would be able

- To have elaborate knowledge on nucleic acids
- To have better understanding of gene expressions
- To get thorough knowledge on Tumor viruses and oncogenes

THEORY **48hours**

UNITI **12 hours**

Concepts in Molecular Biology: Microbes in molecular-biology.

Organization of Genomes: Prokaryotic genome- Genetic and Physical organization of bacterial genome, Eukaryotic genome–Genetic and Physical organization of nuclear genome

DNA structure and Replication: DNA as Genetic material, Chemistry of DNA, Modes of DNA Replication, Meselson and Stahl's Experiment, θ model, replication fork. Enzymes of DNA replication, preprimosome, primosome and replisome complex. Molecular mechanism of DNA replication, Differences in prokaryotic and eukaryotic DNA replication.

UNIT II **12 hours**

DNA damage and recombination: Types of DNA damage - deamination, oxidative damage, alkylation and pyrimidine dimers; DNA repair – mismatch, short patch repair, nucleotide/base, excision repair, recombination repair and SOS repair. Recombination; Site specific recombination, Homologous recombination, transposition.

UNIT III **12 hours**

Gene Expression: Structure of RNA- Classes of RNA, Chemistry of RNA.

Transcription: Transcription in prokaryotes and eukaryotes, Eukaryotic transcription factors. RNA processing, Ribozymes, Antisense RNA, mi RNA, Si RNA, RNAi and other small RNAs. Inhibitors of transcription and their mechanism of action.

Translation: Role of ribosome and different types of RNA in protein synthesis, deciphering the genetic code, basic feature of genetic code, mechanism of initiation, elongation and termination, Non ribosomalproteinsynthesis.Translationalcontrolandposttranslationalevents.Proteintargeting,proteindegradation,protein folding. Small peptides and therapeutic peptides.

UNIT IV **12 hours**

Regulation of Gene expression: Regulation of gene expression in prokaryotes. Operon concept: lac, trp and arabinose. Regulation of gene expression in Eukaryotes. 2 component regulatory system (Sensor Kinases, response regulators, enhances and silencers): constitutive, regulatory genes. Regulation of gene expression in bacteriophage. Gene silencing – gene regulation after transcription.

Recent trends in molecular biology research: Targeted genome editing: ZFNs, TALENs, CRISPRs gene editing, Knock-ins and Knock–outs. **Oncogenes**, proto-oncogenes, activation of proto-oncogenes

References:

1. Benjamin,L. 1990. Gene 4thedn. Oxford Univ.Press,Oxford.
2. Brown, T. A. 1991. Essential Molecular Biology. A Practical Approach Vol-I & Vol.-II, Oxford Univ. Press. Oxford.
3. Flint, S.J., Enquist, L.W., Drug, R.M., Racaniello, V.R. and Skalka, A.M. 2000. Principles of Virology-Molecular Biology, Pathogenesis and Control. ASM Press, Washington,D.C.
4. Garrett and Grisham.1999.Biochemistry.2ndedn. Saunders college pub.USA.
5. Hartl,D.L.1994. Genetics. Jones and Bartler Publishers, London.
6. Lewin,B.2000. Genes VII.Oxford Univ. Press.
7. Lodish,H.,Berk,A.,Zipursky, S.A.,Matsudaira,P.,Baltimore, D.andDarnell,J.1999.
8. Molecular Cell Biology,W.H. Freeman and Company, NewYork.

MB 3.2 Hardcore: GENETIC ENGINEERING

Course Pedagogy:

- To learn about genetic engineering, principals involved in manipulating genes and DNA.
- To know about cloning strategies and expression systems.
- To acquire basic understanding of techniques in genetic engineering.
- To provide basic knowledge on intellectual property rights and their implications in biological research and product development

Course Outcome:

After the completion of the course students would be able

- To acquire knowledge on the concepts and terminology in genetic engineering.
- Familiar with various cloning strategies in prokaryotes.
- To have awareness of IPR ,the social and ethical issues concerning cloning by genetic engineering

THEORY **48hours**

UNIT I **12 hours**

Introduction to Genetic Engineering: Milestones in the development of genetic engineering. Genetic engineering as tool in biotechnology.Importance of gene cloning and future perspectives.

Tools in Genetic Engineering: Enzymes in genetic engineering. Cloning vectors; Plasmids (pUCseries,pBR 322), Phage vectors (M13, λgt 10 and λZAP series), Ti vector. YAC, BAC vectors and specialist –purpose vectors; Expression vectors (pET vectors, pLITMUS). Synthetic construction of vectors.

UNITII **12 hours**

rDNA Technology: The basic principles of gene cloning strategies: Preparation, Manipulation and Insertion of desired DNA in to vector. Introduction of DNA in to host cells– Transformation, Transduction, Transfection, Microinjection, Biolistics, Electroporation, Liposome fusion.Preparation andapplications of DNA libraries and cDNA libraries.Identification and Selection of recombinants.Applications of gene cloning in Biotechnology, Medicine, Agriculture, Forensic Science, Genetherapy.

UNIT III **12 hours**

Analysis of gene and gene products: Molecular markers. DNA based and PCR - based markers, RFLP,RAPD, AFLP STS, EST, SSCP, VNTR, Microsatellites and mini-satellites. **DNA analysis:** labeling of DNA and RNA probes. Southern and fluorescence in situ hybridization, chromosome walking. PCR –types and applications.

Techniques for gene expression: Northern and Western blotting, Gel retardation technique, DNA foot printing, Primer extension, Reporter assays. DNA sequencing and sequence assembly. Sanger's methods, Next Generation Sequencing, techniques of Site-directed mutagenesis, Shot gun sequencing, chemical synthesis of oligonucleotides. Protein analysis; PAGE, 2D-GEL, **Protein sequencing**-N-terminal sequencing by Edman degradation method, C-terminal amino-acid analysis by carboxy peptidase digestion and Dansyl Chloride method.

UNIT IV **12 hours**

Bioinformatics and Molecular Databases: Primary Databanks–NCBI, EMBL, DDBJ, KEGG; Secondary Databases–UNIPROT; Structural Database–PDB; Alignment: Pairwise and Multiple sequence alignment; Genome Annotation and Gene Prediction; Primer designing**;** Phylogenetic analysis and tree construction.

Safety of recombinant DNA technology: Restriction and regulation for the release of GMOs into Environment. Ethical, Legal, Social and Environmental Issues related to rDNA technology.

Introduction to IPR: Kinds of IPR; patents, copy right, design, trademark, geographical indicators,

Industrial design and trade secrets. India’s new National IP Policy.

References:

1. Brown,T.A.(2010) Gene Cloning and DNA Analysis-An Introduction 6th edn.Black well Science.
2. Brown,T.A. (2011) Introduction to Genetics: A Molecular Approach1st Ed.
3. Setlow,JaneK.(2004) Genetic Engineering: Principles and Methods. Springer.
4. Harvey Lodish, Arnold Berk, ChrisA.Kaiser, Monty Krieger (2007) Molecular Cell Biology 6th Ed. W.H. Freeman and Company, NewYork.
5. Alexander N. Glazer, Hiroshi Nikaido (2007) Microbial Biotechnology Fundamentals of Applied Microbiology2ndEd. Cambridge University Press
6. H.-J.Rehm, G.Reed. (2008) Biotechnology: Genetic Fundamentals and Genetic Engineering,Volume 2,Second Edition. Wiley.
8. Desmond,S.T.andNicholl.(2002)An Introduction to Genetic Engineering. Cambridge Univ. Press. Cambridge
9. Maheshwari,D.K.,Dubey,R.C.andKang,S.C.(2006) Biotechnological Applications of Microorganisms.I.K. International Publishing House. New Delhi.
10. P.K.Gupta.(2008) Molecular Biology and Genetic Engineering. Deep and Deep Publications. India.
11. VK Gupta, MSchmoll,M Maki, MTuohy, MAMazutti. (2013)Applications of Microbial Engineering. CRC Press.
12. J.F.Sambrook and D.W.Russell, ed. (2001), Molecular Cloning; A Laboratory Manual, 3rd ED, Vols 1,2& 3, Cold Spring Harbor Laboratory Press.

MB 3.3 Hardcore: INDUSTRIAL MICROBIOLOGY

Course Pedagogy:

- To give knowledge on strain improvement methods
- To learn different fermentation techniques, bioreactor design, inoculum development.
- To understand techniques involved in down-stream fermentation process

Course Outcome:

After the completion of the course students would be able

- To get knowledge on strain improvement
- To understand methods of manipulating the metabolic pathways to get desired yield.
- To understand industrial production and purification of antibiotics, enzymes, amino-acids and steroids.
- To work in fermentation industry
- To understand the application of the bio-molecules in benefit to mankind

THEORY **48hours**

UNITI **12hours**

Introduction: Fermenter design and types of fermenters, achievement and maintenance of aseptic conditions, Types of fermentation processes (Surface, submerged, Batch, Continuous, solid-substrate, Dual, Fed batch fermentation and its applications),

Industrial Microorganisms: Screening, Isolation. Identification and characterization ofindustrially important microbes. Strain improvement- mutation, recombination-gene regulation and genetic manipulation. Preservation of industrially important microbes. Culture collection centers**.**

UNIT II **12 hours**

Media for Industrial Fermentations: Media formulation, growth factors, carbon, nitrogen, Energy and Mineral sources, buffers, inhibitors, precursors, inducers, Oxygen requirements Antifoam agents and others, Sterilization: Sterilization of bioreactor, media, air and exhaust air and filter sterilization. **Downstream processing and fermentation economics**: Steps in recovery and purification Methods of cell separation – filtration and centrifugation, cell disruption, liquid liquid extraction, chromatography, membrane processes. Fermentation economics- expenses for industrial organisms, strain improvement, media sterilization, heating, cooling, aeration and agitation. Cost of Plant and equipment, batch process cycle time, continuous culture, recovery and effluent treatment, cast recovery due to waste usages and recycling.

UNIT III **12 hours**

Industrial production of energy fuels: Industrial alcohol production: Biosynthesis, methods of production, recovery and applications of ethanol: crab tree and pasture effect, acetone – butanol and glycerol through microbial process.

Industrial production of Organic acids and Enzymes: biosynthesis, media, production process, product recovery and application of citric acid and lactic acid, Enzymes: Fungal and Bacterial Amylase; Bacterial proteases.

UNIT IV **12 hours**

Industrial production of food additives: aminoacid production, methods of production, product recovery of L-Glutamic acid and L-lysine. Commercial uses of Amino acids Vitamins: Commercial production of Vitamin B_{12}, and Riboflavin. Alcoholic beverages (Beer, Wine,)

Industrial production of health care product: Industrial production of β-lactum antibiotic (Penicillin): Biosynthesis, production and recovery. Streptomycin: Biosynthesis, production and recovery. Antitumor and anti-cholesterol agents, SCP and SCO, I P R: Patent Laws: Patent regulations of processes, products and microorganisms.

References:

1. Barsanti, LandGualtieri, P.2005. Algae: Anatomy, Biochemistry, and Biotechnology. Taylorand Francis NewYork.
2. Casida, L.E.1997. Industrial Microbiology. New Age International Publishers.
3. Crueger,W.and Crueger,A. 2003. Biotechnology-Atextbookof Industrial Microbiology. Panima Publishing corporation.
4. Demain,A.L. 2001.IndustrialMicrobiologyandBiotechnologyIIEdition.ASMPress,Washington.
5. Demain, A.L.and Davies,J.E. 1999. Manual of Industrial Microbiology and Biotechnology IInd Edition.ASM Press, Washington.
6. El-Mansi, E.M.T. and Bryce, C.F.A. 2004. Fermentation Microbiology and Biotechnology. Taylor and Francis Group.
7. Horton,H.R.,Moran,L.A.,Scrimgeour,K.G.Perry,M.DandRawn,J.D.2006.Principles of Biochemistry, IV Edition. Pearson Education International. London.
8. Julian E Davies and Arnold L Demain 2009 Manual of Industrial Microbiology and Biotechnology ASM Publisher
9. Maheshwari,D.K.,Dubey,R.C.andSaravanamtu,R.2010. Industrial Exploitation of Microorganisms. I.K. International Publishing House. New Delhi.
10. MansiEl-Mansi,C.F.A. Bryce.2007.Fermentation microbiology and biotechnology. CRCPress.
11. MichaelJWaites, NeilL Morgan, John SRockey, Gary Higton2009.Industrial Microbiology
12. NdukaOkafor2010.Modern Industrial Microbiology and Biotechnology ASM Publisher
13. NupurMathurAnuradha2007IndustrialMicrobiologyALaboratoryManual.
14. PatelAH: 2008 Industrial Microbiology: PBBooks.
15. Patel, A.H.1999. Industrial Microbiology, McMillan India Limited, India.
16. Peppler,H.J. and Perlman,D.1979.Microbial Technology. AcademicPress, NewYork.
17. Peppler, H.J. and Perlman, D. 2005. Microbial Technology: Fermentation Technology Second EditionVolume1. Elsevier India Private Limited.
18. Peppler,H.J.and Perlman,D. 2005.Microbial Technology: Fermentation Technology Second Edition Volume2. Elsevier India Private Limited.
19. Puri, R.S. and Viswanathan, A. 2009. Practical Approach to Intellectual Property Rights. I.K.International Publishing House. New Delhi.
20. RaymondBonnett2010WineMicrobiologyand Biotechnology CRC press
21. Reed.G.1999.Prescottand Dunn's Industrial Microbiology. CBS Publishers and Distributors.

MB 3.4 Soft-core: MEDICAL MICROBIOLOGY

Course Pedagogy:

- To understand the role of normal flora and pathogenic microbes
- To understand the pathogenesis of various diseases
- To understand the various clinical microbiological techniques.

Course Outcome:

After the completion of the course students would be able

- To learn the concept, etiology and epidemiology of infections and mechanisms of infection
- To have knowledge on clinical lab techniques
- To acquire knowledge on control measures of diseases

THEORY **48hours**

UNITI **12 hours**

Introduction to Medical Microbiology: History, Development and scope of Medical Microbiology. Concept of Disease, disorder, syndrome, Communicable diseases- Microbial infections and diseases.Factors responsible for microbial pathogenicity.

Microbial infections: Types of infections, modes of transmission, portal of entry: Urinary tract infection, sexually transmissible infection, Infection of the central nervous system, Infections of circulatory system, Oral cavity and respiratory infection, gastrointestinal infection.

UNITII **12 hours**

Nosocomial infection: Incidence of nosocomial infections, types of nosocomical infections, emergence of antibiotic resistant microorganisms, hospital infection control programs, preventing nosocomical infections and surveillance, General concepts for specimen collection and handing of specimen, specimen processing and biosafety.

Chemotherapeutic agents: antibiotics (Classification based on chemical structure, mode of action and range of effectiveness). Recent trends-Drug resistance and its consequences, antibiotic policy, NCCLS (CLSI) guidelines and standards, WHO guidelines.MDR strains.

UNITIII **12 hours**

Epidemiology, Pathogenesis, Spectrum of disease, **Laboratory diagnosis and Prevention:** Diseases caused by Viruses**:** Chicken pox, Rabies virus, hepatitis, encephalitis, AIDS, Herpes simplex infections, Influenza, Dengue

Diseases caused by Bacteria: Tuberculosis, Leprosy, cholera, Typhoid, Botulism, Shigellosis, Helicobacterpylori infection, Salmonellosis, Tetanus. Diseases caused by Fungi**:** Candidiasis, Histoplasmosis, Blastomycosis, Coccidiomycosis, Dermatomycosis, Aspergillosis and Cryptococcosis, Anthrax

UNITIV **12 hours**

Diseases caused by Mycoplasma: *Mycoplasma pneumoniae, M. urealyticum, M. homonis*.

Diseases caused by Protozoa: Giardiasis,Trichomoniasis, Celebral Malaria, Toxoplasmosis, Cryptosporidium.

Disease caused by Chlamydiae: Psittacosis, LymphogranulomaVenereum, Trachoma and Inclusion conjunctivitis.

Emergent Diseases: Hemorrhagic fever, Swine flu, SARS, Chikungunya, Ebola, Hanta, Leptospoirosis, Marburg

References:

1. Robert W. Bauman Ph.D. (2011) Microbiology with Diseases by Body System (3rd Edition); Benjamin Cummings
2. PatrickR. Murray PhD, Ken S.Rosenthal PhD, MichaelA. Pfaller MD (2012)Medical Microbiology; Saunders
3. Brooks,GeoF.,Carroll,KarenC.,Butel,JanetS.(2012)JawetzMelnick&AdelbergsMedicalMicrobiology; McGraw-Hill Medical Publishing Division
4. Kenneth Ryan,C.GeorgeRay,Nafees Ahmad,W.LawrenceDrew,MichaelLagunoff,PaulPottinger,L. Barth Reller, Charles R. Sterling (2014)
5. Sherris Medical Microbiology, Sixth Edition; McGraw-HillMedical Robert W. Bauman Ph.D. (2011) Microbiology with Diseases by Body System (3rd Edition); Benjamin Cummings
6. TimothyJJInglis (2013) Clinical Microbiology and Infectious Diseases; Point of Care Publications
7. Patricia Tille (2013) Bailey & Scott's Diagnostic Microbiology; Mosby Marjorie Kelly Cowan (2012) Microbiology Fundamentals: AClinical Approach; McGraw-HillScience/Engineering/Math
8. Connie R. Mahon,DonaldC. Lehman, George ManuselisJr. (2010) Text book of Diagnostic Microbiology; Saunders
9. Ananthanarayan, Paniker (2009) Textbook of Microbiology,8th Edition; UniversityPress
10. Jawetz (2010) Medical Microbiology, 25th Edition; Tata McGraw –Hill Education

MB 3.5 Soft-core: CLINICAL & DIAGNOSTIC MICROBIOLOGY

Course Outcome:

After the completion of the course students would be able

- To develop skill to isolate and identify microorganism form clinical sample.
- To do antibiotics sensitivity and resistance test
- To do detection of parasite/pathogens using diagnostic kits.

Course Pedagogy:

- Knowledge about microbes causing disease.
- Knowledge about various laboratory techniques like microscopy, immunological assessments, radiology, biomarker tests, ELISA, serology checks, vaccines and vaccines schedule.
- Many microbes have developed resistance to medications.

THEORY **48hours**

UNITI **12 hours**

Introduction to clinical Microbiology: Role of Microbiologist in Diagnostic laboratory, General concepts for specimen collection, handling, transportation, processing, specimen workup, Laboratory safety and infection control.

Scientific and Laboratory basis for Clinical/Diagnostic Microbiology: Microscopic examination of infectious diseases, Growth and biochemical characteristics, Rapid methods of identification.

UNIT II **12hours**

Immunotechniques and Immunodiagnosis: Antigens and Antibody reactions *in vitro;* Agglutination, complement fixation, ELISA, Western Blotting Immuno-diffusion, Immuno-electrophoresis, Immunoflurescence, Immuno-precipitation, Radioimmuno assay and serotyping.

Vaccines and Vaccination: Vaccines – definition, types, Antigens used as Vaccines, effectiveness of vaccines, Vaccine safety, current vaccines, adjuvants, active immunization and passive immunization.

UNIT III **12 hours**

Recent Diagnostic tools and techniques: Principle, working and application of a) Autoanalyser b)Biosensor glucometer /labon chip/microfluidics c) Diagnositic kits- ELISA, Western Blot d) Enzymes inDiseasediagnosisandtherapy:Lactatedehydrogenase,Aspartateaminotransferase,Alkalinephosphatase,Creatinekinase, Acid phosphotase, Cholinesterase.

UNIT IV **12 hours**

Antimicrobial Chemotherapy: Development of chemotherapy; General characteristics of drugs and their testing; Mechanism of action. Antibacterial drugs; antifungal drugs, antiviral and antiprotozoan drugs; antibiotic sensitivity testing, MIC, Drug resistance; mechanism of drug resistance; multi drug resistance

Reference

1 Alberto M. Marchevsky and Mark Wick. (2011). Evidence Based Pathology and Laboratory Medicine. Springer publication.

2 DavidE. Bruns; Edward R.Ashwood; CarlA. Burtis; Barbara G.Sawyer (2007). Fundamentals of Molecular Diagnostics St. Louis, Mo. : Saunders Elsevier

3 GouraKudesia (2009) Clinicaland DiagnosticVirology. Cambridge University Press.UK.

4 HenrikWinther and JanT.Jorgensen (2010).Molecular Diagnostics. Springer publications.

5 Huggettand Justin O'Grady *LGC (2014)* Molecular Diagnostics: Current Research and Applications. Caister Academic Press.

6 HuwLlewelyn , Hock AunAng, Keir E Lewis and Anees Al-Abdullah (2009). Oxford Handbook of Clinical Diagnosis. Oxfordpublications.

7 J.Andre Knottnerus and Frank Buntinx (2008) The Evidence Base of Clinical Diagnosis: Theory and Methods of Diagnostic Research, 2nd Edition. Wiley Publication.

8 Peter HuMadhuriHegdeand PatrickAlan Lennon (2012). Modern Clinical Molecular Techniques. Springer publications.

9 PrakashS.Bisen,MousumiDebnathand GBKSPrasad (2010) Molecular Diagnostics: PromisesandPossibilities. Springer publications

10 Richard A. McPhersonand MatthewR. Pincus (2011). Henry's clinical diagnosis and management by laboratory methods. (22nd Edi) Philadelphia, PA :Elsevier/Saunders,

11 StephenB. Hulley; StevenR. Cummings; WarrenS.Browner; DeborahG.Grady; ThomasB. Newman (2007) Designingclinicalresearch(3rdedition). Philadelphia, PA: Lippincott Williams & Wilkins.

12 VinayKumar etal.,(2010) Robbins and Cotran pathologic basis of disease. Philadelphia, PA:Saunders/Elsevier.

MB3.6Soft-core: PRACTICALV (Molecular Biology and Genetic engineering)

1. Isolation of Genomic DNA from *E.coli*.
2. Isolation of plasmids from bacteria by agarose gel electrophoresis.
3. Determination of purity and concentration of isolated DNA using spectrophotometer
4. Estimation of DNA by DPA method
5. Determination of DNase activity on isolated DNA
6. Amplification, Purification and separation of PCR product.
7. Estimation of RNA by Orcinol Method
8. Determination of RNase activity on isolated RNA.
9. Salt fractionation of Yeast protein and quantification
10. Estimation of protein by Lowry's method
11. Determination of Proteinase activity on proteins
12. Separation of proteins by SDS PAGE
13. Digestion of the gene of interest with suitable restriction enzymes.
14. Ligation of the digested gene in a vector.
15. Preparation of competent *E.coli*cells for Bacterial transformation.
16. Transformation of the vector in to the host cell and selection of the desired clones.
17. Induction of gene expression and purification of the induced protein from the host.

MB 3 .7 Soft-core: PRACTICALVI (Industrial and Medical Microbiology)

1. Study design of Fermentor and Parameters
2. Isolation of antibioticproducing microbes and their preservation.
3. Antibiotic fermentation and estimation of penicillin
4. Batch fermentation of Citric acid production, recovery and estimation of citric acid.
5. Preparation of wine and estimation of alcohol by specific gravity method.
6. Alcoholic fermentation and determination of total acidity and non-reducing sugars
7. Clarification of banana juice using Pectinase
8. Mushroom cultivation
9. Isolation of Pathogenic fungi of the skin (Dermatophytes).
10. Isolation and identification of clinically important microbes from throat swab
11. Isolation and identification of clinically important microbes from nasal swab
12. Isolation and identification of clinically important microbes from wound infections
13. Microbial flora of mouth–teeth crevices and saliva.
14. Estimation of bacteria in urine by calibrated loop direct streak method.
15. Antimicrobial assay–sensitivity test (MIC) for pathogenic bacteria.
16. Demonstration of laboratory diagnosis of important human diseases:–Tuberculosis, Typhoid, Malaria, and Hepatitis.

MB 3.8 Open elective: MICROBIAL DIVERSITY

Course Pedagogy:

- To understand the ubiquitous nature and characteristics of microbes
- To impart knowledge on viral, bacterial, fungal diversity.
- Importance and conservation of microbial diversity.

Course Outcome:

After the completion of the course students would be able

- To differentiate various groups of Microbes.
- To learn about conservation methods.
- To have knowledge about the role of culture collection centers in conservation.

THEORY **48 hours**

UNIT I **12 hours**

Viral Diversity: Morphology, ultra structure, chemical composition of virus, classification of viruses, Group I – T2 Bacteriophage, Group II – Banana bunchy top virus, Group III – Reovirus, Group IV-TMV, GroupV– Rhabdovirus, Group VI– HIV, Group VII–Hepatitis virus.

Sub-viral particles: Discovery, Structure, Classification, replication and diseases caused by Satellite, Satellites virus, Virusoids, Viroids and Prions.

UNIT II **12 hours**

Bacterial Diversity: Archaebacteria, Photosynthetic Eubacteria, Chemoautotrophic and Methophilic Eubacteria, Gliding Eubacteria, Spirochetes, Rickettsiae and Chlamydiae, Actinomycetes, Mollicutes, Protists. Classification based on Bergey's manual (Determinative& Systematic).

UNIT III **12 hours**

Fungal Diversity: Classification, Distribution, Importance, Structure, reproduction and general characteristics of the fungal divisions: Zygomycota (*Rhizopus*), Ascomycota (*Neurospora*), Basidiomycota (*Agaricus*), Deuteromycota (*Penicillium*), Chytridiomycota (*Allomyces*) , Myxomycota and Yeast.

UNIT IV **12 hours**

Importance and Conservation of Microbial Diversity: Importance of microbial diversity in agriculture, forestry, environment, industrial & food biotechnology, animal & human health. Metagenomics.Importance of conservation.*In situ* conservation and *Ex situ* conservation. Role of culture collection centers in conservation.

References

1. Alexopoulos, C.J. and Mims, C.W. 1979. Introductory Mycology. III edition, Wiley Eastern, New Delhi.
2. Dimmock, N. J., Easton, A. J. and Leppard, K. N. 2001. Introduction to Modern Virology. 5th edn. Blackwell publishing, USA.
3. Ghosh, A. 2003. Natural Resource Conservation and Environment Management. Aph Publishing Corp. Calcutta.
4. Landecker, E.M. 1972. Fundamentals of Fungi. Prentice-Hall, Angelwood Cliff, New Jersey.
5. Madigan M.T., Martinko M.J. and Parker, J. 2003. Brock Biology of microorganisms. Pearson education., New Jercy.
6. Pelczar, (Jr.) M.J., Chan, E.C.S. and Kreig,N.R.1993. Microbiology. McGraw Hill, New York
7. Perry, J.J. and Staley, J.T. 1997. Microbiology. Dynamics and Diversity. 4thedn. Wesley Longman pub. New York.
8. Presscott, L. M., Harley, J. P. and Klein, D. A. 1999. Microbiology. 4thedn. WCB McGraw- Hill, New Delhi.
9. Satyanarayana, T. and Johri, B. N. 2005. Microbial Diversity – Current Perspectives and Potential Applications. I K Int. Pvt. Ltd. New Delhi.
10. Stainer, R. Y., Ingraha, J, L, Wheelis, M. L. and Painter, P. K. 1986. General Microbiology. McMillan Edun. Ltd. London.
11. Stanley J.T. and Reysenbach A.L.1977. Biodiversity of microbial life. John Wiley 7 Sons Inc. Publication. New York.
12. Wagner, E.K. and Hewlett, M.J. 1999. Basic Virology. Black well Science. Inc.

SEMESTERIV

MB4.1Hardcore: AGRICULTURAL MICROBIOLOGY

Course Pedagogy:

- To study the microbes associated with the plant and soil fertility.
- To understand about beneficial microbes and their uses in protecting agriculture, preserving food, enhancing the value of food products and providing general benefits to health and wellbeing.
- To classify various aspects of N2 fixation, P solubilization, PGPR, are easily grasped by students
- To understand microbe and plant interactions
- Enable them to understand plant disease, plant defense mechanism and disease management.

Course Outcome:

After the completion of the course students would be able

- To develop newer approaches for plant disease management.
- Have better knowledge of pathogen interactions and plant defense mechanisms
- To know the application of microbial bio-control agents and to reduce drug resistance and environmental pollution.

THEORY **48hours**

UNITI **12 hours**

Introduction to Agricultural Microbiology: Introduction to agricultural microbiology, concepts and scope of agricultural microbiology, Agronomy and production of important crop plants, Green revolution. Plant Pathology: Concept of disease, History of Plant Pathology, Significance of plant diseases, Symptoms and types of plant diseases.

Plant Pathology in Practice: Plant Clinic and Plant Doctor Concept. Diagnosis of Plant Diseases – Infectious diseases, Non-infectious diseases, Koch's rules;

UNITII **12 hours**

Parasitism and Disease Development Parasitism and pathogenecity, Host range of pathogens, Disease triangle, Diseases cycle / Infection cycle, Relationship between disease cycles and epidemics; Pathogens Attack Plants–Mechanical forces, Microbial enzymes and toxins, Growth regulators. Effect on physiology of Host–Photosynthesis, Translocation and transpiration, Respiration, Permeability, Transcription and translation.Environment and Plant Disease– Effect of Temperature, Moisture, Wind, Light, Soil, pH and structure, Nutrition and Herbicides.

Defense Mechanisms of Plant: Disease Pre-existing structural and chemical defenses, Induced structural and biochemical defenses. Microbe mediated strategies for abiotic stress management.

UNITIII **12 hours**

Plant Disease & their management: Tobacco Mosaic Disease, Sandal Spike Disease, Bacterial blight of Paddy, Citrus canker, Angular leaf spot of cotton, Late Blight of Potato, Downy Mildew of Bajra, Blast of paddy, Tikka disease of ground nut, Rust of coffee, Grain and Head smut of Sorghum. Powdery mildew of Cucurbits, Wilt of Tomato, and Root Knot of Mulberry.Bunchy top of Banana.

UNITIV **12 hours**

Microbes and Plant interaction- Mycorrhizae- Biology and their applications, Bio fertilizers – microbial inoculants.Production and application of *Rhizobium, Azospirillum, Azotobacter,* phosphor bacteria and Cyanobacteria.PGPR's plant growth promoting *Rhizobacteria*and their uses.

Biopesticides: Definition, types- bacterial, viral, fungal and protozoan, mode of action, target pests, use of transgenic plants. Mode of action, Bacteria- endo and ecto- toxins production by *Bacillus thuringiensis, and Pseudomonas.*Fungi- *Beauveria, Cephalosporium,* and *Trichoderma.*

References:

1. George.N. Agrios(2005), Plant pathology, Elsevier academic press, 5thedition,U.K.
2. Mehrotra. R.S. and Ashok Aggarwal (2002), Plant pathology, Tata MC Graw-Hill publishers, 2ndedition, Delhi.
3. Kannaiyan.S. (2002), Biotechnology of Biofertilizers, Alpha science international,1st edition.
4. Bagyaraj D.G. and Rangaswami. G. (2005). Agricultural Microbiology, Prentice- Hall of India, 2ndedition, New Delhi.
5. NeelimaRajvaidya and Dilip Kumar Markandey. (2006). Agricultural Applications of Microbiology, NangiaS.B. And A.P.H.publishing corporation, New Delhi.
6. Oerke,E.C.Dehne,H.C. Schönbeck, F.Weber,A.(1999).Crop Production and Crop Protection, Elsevier academicpress, 5th edition,U.K.
8. RogerHull (2013). Plantvirology, Elsevier academic press,11th edition, U.K.
9. Hermann H. Prell, Peter R. Day. (2001). Plant-Fungal Pathogen Interaction: A Classical and MolecularView,1st edition, Springer-Verlag Berlin Heidelberg, Germany.
10. Geoffrey Clough Ainsworth (1981). Introduction to the History of Plant Pathology 1st edition, Cambridge university press, U.K.
11. Vidhyasekaran,P.(2007).Fungal Pathogenesis in Plants and Crops: Molecular Biology and Host Defense Mechanisms, 2nd edition, APS press, U.S.A

MB 4.2 Soft-core: ENVIRONMENTAL MICROBIOLOGY

Course Pedagogy:

- To give basic idea on environmental sample analysis; Topics covered in detail include soil microbiology, aquatic microbiology, aero microbiology, bio-fertilizers and pesticides, microbial waste recycling and bioremediation etc.
- To understand the basic principles involved in waste water management
- To get the information on usage of Bioremediation- biotechnology
- To inform students about Bio-oxidation & microbial leaching

Course Outcome:

After the completion of the course students would be able

- To apply advanced knowledge on environmental sample analysis
- To use the knowledge for better waste management
- To formulate technique for bioremediation process
- To apply principles of environmental microbiology to solve the current environmental issues
- To be employable in pollution control boards

THEORY **48 hours**

UNIT I **12 hours**

Environment and Ecosystem: Physical, chemical and biological aspects of environment, natural habitats of microorganisms, microorganisms in ecosystem as producers and decomposers.

Soil Microbiology: Characteristics and classification of soil. Interactions between microorganisms: Mutualism, commensalism, ammensalism synergism, parasitism, predation, competition. Rhizosphere, rhizosphere, microflora and its beneficial activity.Role of microorganism in nitrogen, phosphorous and sulphurcycle.Detrimental effects of diverted biogeochemical cycles. Biological nitrogen fixation in detail: Symbiotic, asymbiotic and associated nitrogen fixation. Structure, function and genetic regulation of nitrogenases.

UNIT II **12 hours**

Air Microbiology: Microorganisms in air, sources of air-borne microorganisms.Airspora of indoor and outdoor environment, factors affecting airspora, Techniques of trapping air borne microorganisms.
Brief account of air-borne diseases of humans, plants and their significance.

Aquatic Microbiology: Distribution of microorganisms in the aquatic environment, Water pollution sources, Biological indicators of water pollution. Eutrophication- role of nitrogen and phosphorus in eutrophication, process and control of eutrophication.Determination of sanitary quality of water, Waste water microbiology-Primary, secondary, tertiary treatment and reclamation of wastewater.

UNITIII **12 hours**

Culture- dependent and independent approaches for microbial diversity in environment.

Culture- dependent approaches and their limitations, and culture-independent molecular approaches for understanding microbial diversity in the environment.Viable but non-culturable bacteria.Introduction to Metagenomics.

Microbes in extreme environment: acidophiles, alkaliphiles, halophiles, barophiles and their survival mechanisms.

Space microbiology: Historical development of space microbiology, Life detection methods a) Evidence of metabolism (Gulliver) b) Evidence of photosynthesis (autotrophic and heterotrophic).

UNITIV **12 hours**

Microbes in the degradation of wastes: Treatment of solid and liquid industrial wastes, Microbial degradation of pesticides, Xenobiotics, degradation of lignin, cellulose, pectin and plastic. Bio-remediation. Geo microbiology: Microbes in metal extraction, mineral leaching and mining, copper extraction byleachingandmicrobesinpetroleumproductformation.GlobalEnvironmental Problems: Global Warming, Acid rain, Ozone depletion. Bio- deterioration of wood and metals.

References:

1. Microbial Ecology by R.M. Atlas, R. Bartha. 3rd edition. Benjamin Cummings Publishing Co, USA. 1993.
2. Environmental Microbiology by A.H. Varnam, M.G. Evans. Manson Publishing Ltd. 2000.
3. Manual of Environmental Microbiology edited by C.J. Hurst, R.L. Crawford, J.L. Garland,
4. D.A. Lipson, A. L. Mills, L.D. Stetzenbach. 3rd edition. Blackwell Publishing. 2007.
5. Environmental Microbiology edited by R. Mitchell, J-D Gu. 2nd edition. Wiley-Blackwell. 2009.
6. Environmental Microbiology by R. Maier, I. Pepper, C. Gerba. 2nd edition. Academic Press. 2009.
7. Environmental Microbiology: Principles and Applications by P.K. J jemba, Science Publishing Inc. 2004.
8. Lignocellulose Biotechnology: Future Prospects by R.C. Kuhad, A. Singh. I.K. International. 2007.
9. Environmental Microbiology of Aquatic & Waste systems by N. Okafor. 1stedition, Springer, New York. 2011
10. Bioremediation by Baker K.H. and Herson D.S. 1994.. Mac Graw Hill Inc. N.Y.
11. Waste Water Engineering - Treatment, Disposal and Re-use by Metcalf and Eddy, Inc., Tata MacGraw Hill, New Delhi.
12. Pollution: Ecology and Biotreatment by EcEldowney, S. Hardman D.J. and Waite S. 1993. - Longman Scientific Technical.
13. Environmental Microbiology edited by Ralph Mitchell. A John Wiley and Sons. Inc.
14. Waste Water Microbiology 2nd Edition by Bitton.
15. Chemistry and Ecotoxicology of pollution. Edited by Des. W. Connell, G.J. Miller. Wiley Interscience Publications.
16. Environmental Biotechnology. Edited by C. F. Forster and D.A., John Wase. Ellis Horwood Ltd. Publication.
17. Advances in Waste Water Treatment Technologies. 1998. Volumes II and I by R. K. Trivedy. Global Science Publication.
18. Biocatalysis and Biodegradation: Microbial transformation of organic compounds. 2000 by Lawrence P. Wacekett, C. Douglas Hershberger. ASM Publications.
19. A Manual of Environmental Microbiology. 2nd Edition. 2001 by Christon J. Hurst (Chief Editor), ASM Publications.
20. Biodegradation and Bioremediation, Academic Press, San Diego.
21. Biotechnology in the sustainable environment, Plenum Press, N.Y.
22. Basic Principles of Geomicrobiology by A. D. Agate, Pune.

MB 4.3 Soft-core*:* GENOMICS AND PROTEOMICS

Course Pedagogy:

- The objectives of this course are to provide introductory knowledge concerning genomics, proteomics and their application
- To have knowledge about bioinformatics using web based tools (NCBI, CLUSTALW, MSA etc.,)

Course Outcome:

After the completion of the course students would be able

- To acquire knowledge and understanding of the fundamentals of genomics and proteomics, transcriptomics and their applications in various applied areas of biology.
- Do Insilco analysis using web based tools, will help the students in their research

THEORY **32 hours**

UNIT I **8 hours**

Genome - Overview of Genome; Sequence of Genome Acquisition and Analysis - Homologies - Snps – Genetic Analysis, Linkage Mapping,

High Resolution Chromosome Mapping And Analysis - Physical Mapping, Yac, Hybrid Mapping, Strategies, Sequence Specific Tags (Sst), Sequence Tagged Sites (Sts), Ish, Fish, Rflp, Rapd.

UNIT II **8 hours**

DNA Sequencing- Methods, Maxam and Gilbert Method, Ladder, Fluorescent, Shot Gun, Mass Spectrometry, Automation Sequencing – Find Gene Mutations, Implications of DNA – Sequencing and Sequencing Genomes.

Genome Data Bank, Metabolic Pathway Data - Construction And Screening of cDNA, Libraries And Microarrays - Application Of DNA Arrays - PCR - Variations In PCR - Gene Disruptions – Sage And Sade, Pharmacogenomics.

UNITIII **8 hours**

Protein Sequence Analysis - Introduction - Sequence Data Banks - Wbrf – Pir - Swissport - Databases, Data Mining – Algorithms Of Proteomics And Its Applications- Protein Expression**Profiling -** Protein- Protein Interaction - Protein Modifications. Automation-Nucleic Acid Data Bank –EMBL Nucleotide Sequence Data Bank- Aids Virus Sequence Data Bank-RNA Data Bank.

UNITIV **8 hours**

Tools For Data Bank - Pairwise Alignment - Needleman And WuschAlgorighm – Smith Waterman - Multiple Alignment- Clustral - Pras - Blast - Fast, Algorithms To Analyse Sequence Data- Pdb, Cambridge Structure Data Base (Lsd), 2d Electrophoresis, Ief, Hplc, Protein Digestion Technique, Mass Spectrometry, Maldi-Tof, Peptides, Mass Finger Printing Protein.

Metabolomics: Introduction, importance of metabolomics, designing of metaboilimic study. Data base for repository of metabolites, CHEBI, EMBL, EBI, reactome data base.

References

1. DevarajanThangadur and JeybalanSangeetha(2015). Genomics and Proteomics Principles, Technologies, and Applications. Apple Academic Press.
2. FerencDarvas, AndrásGuttman, GyörgyDormán(2013). Chemical Genomics and Proteomics (2nd Ed). CRC Press.
3. Ganapathy Subramanian and Nawin Mishra (2012). Science of Proteomics: Historical Perspectives and Possible Role in Human Healthcare. WileyPublications.UK
4. Lynn Jorde, Peter Little, Mike Dunn and Shankar Subramaniam (2014). Encyclopedia of Genetics, Genomics, Proteomics and Bioinformatics. WileyPublication.UK
5. Malcolm Campbell, Laurie J. Heyer (2003). Discovering genomics, proteomics and bioinformatics. Benjamin Cummings publications.
6. MetinAkay (2007). Genomics and Proteomics Engineering in Medicine and Biology. WileyPublications.UK.
7. NachimuthuSaraswathy and PonnusamyRamalingam (2011). Concepts and Techniques in Genomicsand Proteomics .Wood head Publishing groups.
8. Nawin Mishra (2010).Applications of Proteomics: Proteomics, Human Disease, and Medicine. Wileypublication.UK
9. R. S. Dassanayake, Y. I. N. Silva Gunawardene (2011). Genomic and Proteomic Techniques: In Post Genomics Era. Narosa Book Distributors.
10. Ruchi Singh (2014). BIOINFORMATICS: GENOMICS AND PROTEOMICS. Vikas Publications. New Delhi.
11. Suhai, Sándor (2002). Genomics and Proteomics. Springer publications.

MB 4.4 Soft core: Microbial Nanotechnology

Theory **48 hours**

Unit I **12 hours**

Introduction to Nanotechnology: Characteristic scale for quantum phenomena, nanoparticles, nano-clusters, nanocomposite, nanotubes, nanowires and Characterization of nanoparticles – UV-VIS IR spectroscopy, TEM, SEM, AFM, EDS, XRD. Emergence of bionanotechnology.

Unit II **12 hours**

Microbial nanotechnology – Microbial synthesis of Nanoparticles.Synthesis of nanodrugs – metal nanoparticles and drug delivery vehicles – Nanoshells – Tectodentrimers Nanoparticle drug systems – Diagnostic applications of nanotechnology.

Unit III **12 hours**

Preparation of nano biomaterials – Polymeric scaffolds collagen, Elastins: Mucopolysaccharides, proteoglycans, cellulose and derivates, Dextrans, Alginates, Pectins and Chitin. Nanoparticles – types (Silver, Gold and Titanium). Physical and chemical properties and functions. Drug delivery – protein mediated and nanoparticle mediated. Hybrid conjugates of gold nanoparticles – DNA oligomers in nano mechanics and Computing. Nanoparticles as carrier for genetic material.

Unit IV **12 hours**

Applications in biology and medicine: Nanotechnologies for biology and medicine – Micro and nano- fluidics - Scanning probe microscopy in biology and medicine – Self-assembly of biological molecules.

Health and safety implications: Health issues – Environmental issues – regulation guidelines. Societal implications- Possible military applications – Potential benefits and risks to developing countries – Intellectual property issues – Criticism of Nanotechnology.

Reference Books:

1. Parthasarathy, B.K. (2007). Introduction to Nanotechnology, Isha Publication.
2. Elisabeth Papazoglou and AravindParthasarathy (2007).Bionanotechnology. Morgan & Claypool Publishers.
3. Bernd Rehm (2006). Microbial Bionanotechnology: Biological Self-assembly Systems and Biopolymer-based Nanostructures. Horizon Scientific Press.
4. David E. Reisner, Joseph D. Bronzino (2008). Bionanotechnology: Glo
5. ChaudheryHussain (2022) Handbook of Microbial Nanotechnology, 1st Edition.

MB4.6Soft-core: PRACTICAL VII (Agricultural Microbiology)

1. Isolation of Rhizobium from roots of leguminous plants
2. Assay of bio-fertilizers (*Rhizobium, Azotobacter, Azospirillum)* (Seed treatment/ seedling inoculation and measurement of root and shoot length)
3. Mass multiplication techniques of *Azolla.*
4. Estimation of total phenols in diseased and healthy plant tissues.
5. Isolation of phosphate solubilizing bacteria and fungi.
6. Isolation of phylloplane microorganisms
7. Soil microbes interaction In vitro by dual culture method
8. Isolation, identification and enumeration of Rhizosphere and Rhizoplane microorganism
9. Seed health testing by SBM
10. Collection and Identification of following disease:

1. Tobacco mosaic disease
2. Bunchy top of Banana
3. Bean Mosaic
4. Sandal spike
5. Bacterial blight of paddy
6. Citrus canker
7. Downy mildew of Bajra
8. Powdery mildew of mulberry
9. Head smut of sorghum
10. Leaf rust of coffee
11. Blast disease of paddy
12. Tikka disease of groundnut
13. Leaf spot of paddy
14. Grassy shoot of sugarcane

MB 4.7 Soft-core: PRACTICAL VIII(Environmental Microbiology Practical)

1. Microbes as indicators of water pollution– Determination of indices of water quality.
2. Determination of TS from Sewage Water
3. Determination of BOD of pollution water.
4. Determination of COD of polluted water.
5. Degradation of cellulose by Chaetomiumglobosum.
6. Study of Actinorhiza, Mycorrhiza.
7. Isolation of pesticide degrading microbes
8. Isolation of plastic degrading microbes

MB 4.8 Soft-core: PRACTICAL IX: Microbial Nanotechnology Practical

1. Synthesis of gold Nano particles from bacteria and its confirmation by UV-Spectroscopy
2. Synthesis of gold Nano particles from fungi and its confirmation by UV-Spectroscopy
3. Synthesis of silver Nano particles from bacteria and its confirmation by UV-Spectroscopy
4. Synthesis of silver Nano particles from fungi and its confirmation by UV-Spectroscopy
5. Synthesis of Nano metal particles from microbes and its confirmation by UV-Spectroscopy
6. Evaluation of antimicrobial properties of gold Nano particles produced by microbes
7. Evaluation of antimicrobial properties of silver Nano particles produced by microbes
8. Determination of MIC values of synthesized nanoparticles
9. Evaluation of plant growth promotion of Nano metals/composites.
10. Determination of size of nanoparticles by SEM/TEM
11. Characterization of nanoparticles by using XRD, EDX and DLS